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Broadcasting as a Social Service

IN the admirable essay on the British Broadcasting Corporation in the volume of essays "Public Enterprise: Developments in Social Ownership and Control in Great Britain" by a group of contributors belonging to or associated with the New Fabian Research Bureau, Dr. W. A. Robson, while recognizing the achievements of the Corporation, the merits of its organization and the high degree of public spirit in its staff, referred to the deplorable absence of serious criticism and intelligent information concerning broadcasting in Great Britain. The general public indeed is scarcely aware either of the achievements or the shortcomings of British broadcasting, or the possibilities and the dangers of broadcasting as affecting international relations.

A more searching and discriminating attitude towards broadcasting activities is undoubtedly essential if the vitality and future progress of broadcasting are to be assured, and the same plea is advanced in Dr. Cleghorn Thomson's recent suggestive survey of radio development and its problems in our changing world under the title "Radio is Changing Us". Dr. Cleghorn Thomson writes in a disarmingly bantering tone but never loses sight of the serious aspect of his thesis. His seven years' experience inside the British Broadcasting Corporation add weight to many of his criticisms, although his attitude is that of the keen listener, and he lays his main stress on the importance of creative imagination in the development of broadcasting services whether in Great Britain or elsewhere.

Without a more critical approach to broadcasting problems and a more imaginative and creative appreciation of the social and cultural elements involved, technical development is likely to lag far behind what is possible, and much of the value of efforts, such as those of the International Broadcasting Union and the International Committee on Intellectual Co-operation, to use this new means of spreading information in the service of peace and understanding between the nations, may well be lost.

The problems and difficulties so far encountered are, of course, essentially those which have been raised and stressed repeatedly of late, notably in Mr. T. H. O'Brien's study of "British Experiments in Public Ownership and Control" and in the essays on the British civil servant edited by Dr. W. A. Robson. Fundamentally, the problem is one of linking efficient administration and effective safeguards against abuse or damage to the public interest with the creative imagination which is alive to the human and social issues involved and the service which technical developments can render to them. It is this which has brought into the forefront at the present time the whole question of training for administration, and the importance of securing those who possess the scientific background to assess technical factors as well as creative ability and the capacity to promote energetic and far-reaching projects. Caution and regard to existing interests can never be a substitute for vision and initiative; and the severest criticism that has been made of the Governing Board of the British Broadcasting Corporation is just that its personnel does not inspire confidence in its contact with progressive thought, its receptivity to new ideas and its capacity to promote energetic development. It suggests the retrospective rather than the forward-looking mind which is so imperatively needed in such positions to-day.

Statements in the Press that the quality of broadcasting programmes in Great Britain is likely to be affected by the financial stringency through which the British Broadcasting Corporation is passing give further point to some trenchant criticism by Dr. W. A. Robson in the essay to which we have alluded. Dr. Robson notes that the British Broadcasting Corporation, a public service undertaking carried on without a divisible profit on a self-supporting basis, has been required over a long period of years to pay to the Treasury out of its licence revenue not only a heavy percentage deduction amounting in 1934 to £1,134,315 out of £3,369,000 but also a series of "emergency contributions" levied annually to meet the financial crisis of 1931, amounting in 1934 to £187,500, as well as a further sum by way of income tax amounting to £113,000 in the same year. Thus in 1934, out of each ten shillings paid for a licence, only 4*s*. 9*d*. was available for broadcasting, and, though the Government has accepted the view of the Ullswater Committee that the Corporation should receive a larger share of the licence revenue, the change is estimated to bring the net licence revenue in 1937–38 to £2,800,000, on which basis about 6*s*. 5*d*. out of the ten shilling licence will be available for the broadcasting service.

This, therefore, is a step in the right direction; but on any broad or long-range view of the broadcasting service these payments must all be regarded as unjustifiable. They are drained out of the broadcasting revenue derived from the licence fee at the expense of the listener, and are due to demands made by the Treasury, regardless of the purposes for which new enterprises are run.

What is needed here is, of course, some central planning organization which is competent not merely to stimulate such a philosophy of public finance, but also to assess the significance of broadcasting as an element in the social services or educational system of the nation, and to determine the broad lines along which it can work out its own policy and contribution in harmony with other public or social services. Only in such a way can we be sure that adequate financial resources will be available, and machinery developed for co-ordinating the work when required and avoiding friction or overlapping between different public utilities or services.

This is, of course, a matter involving much more than questions of finance alone. It affects questions of technical development, the recruitment of staff and most matters in which the utilization of creative thought, a scientific outlook and progressive opinion are concerned. Above all, it means constructive and fundamental thought about the place of broadcasting in national economy and its contribution to cultural or social development as a basis for the framing of a policy. Moreover, if, as Mr. Cleghorn Thomas holds, it is in its contribution to the fuller and more abundant life—in the stimulation of intellectual life and individuality in the arts, the sciences, the humanities—that broadcasting can most permanently justify itself, the fullest opportunity for its expression can only be secured when those in direct or indirect control of it are fully alive to the opportunities it holds and in sympathy with the service it can render to humanity.

The danger indeed is not greater in the financial than in the political or other spheres. Indeed one reason why the public should be afforded much more information about the expenditure of the British Broadcasting Corporation, as urged by Dr. W. A. Robson and Mr. T. H. O'Brien, is to facilitate an intelligent understanding of the work which the Corporation is doing and the way in which financial difficulties hamper development. The attention focused upon staff problems and especially recruitment by Dr. Herman Finer in his essay in "The British Civil Servant" is of significance because of the vital importance of securing staff and conditions of service in which the psychological atmosphere is favourable to creative thought and imaginative development. The relations of the Corporation to the Government and the composition of its Governing Board similarly not only affect these matters but also the firm establishment of continued belief in the impartiality of the Corporation, its freedom from propaganda and prejudice and its willingness and ability to serve the changing needs of the public to the maximum of its opportunities, both within the territorial limits of the nations and on the international scale also. The appeal for constructive criticism which is so striking a note in Mr. Cleghorn Thomson's book and in the other essays we have noticed is founded on the belief that only by such means can an institution be assisted to develop its services and keep itself imaginatively alive to the magnitude of its opportunities. In such criticism scientific workers have a part to play which has special claims upon their interest, because of the rapidity with which the problems presented have themselves arisen out of the application of scientific discovery and thought.

From Galileo to Einstein

The Evolution of Physics: the Growth of Ideas from the Early Concepts to Relativity and Quanta. By Albert Einstein and Leopold Infeld. (Cambridge Library of Modern Science.) Pp. x+319+3 plates. (Cambridge: At the University Press, 1938.) 8*s*. 6*d*. net.

THE interpretation of science to the lay reader—and we may quite candidly admit that 'lay reader' must be interpreted as including practically all men of science who do not happen to be professionally interested in the particular branch of science under consideration—is a task both important and difficult. Of books which might be described as being suitable for some "Wonders of the Universe" series there is an excellent supply, and very good some of them are. The universe *is* a wonderful place, and to explore it under the guidance of a distinguished cicerone is both pleasant and profitable. Too often, however, one lays the book down with an uneasy feeling that something is missing. It reads like a detective story from which all the middle pages are missing. The first chapter, with its neatly arranged pile of corpses, is there, and the last page or so in which the name of the villain is disclosed; but the account of the search, and in particular, that thrilling chapter, near the end, where the 'little grey cells' come into play, is wanting, and the real interest of the book has vanished with it. While it is, no doubt, edifying to learn that a lump of matter is nothing but a whirl of flying electric charges, what the reader would like to know, and what it is important that he should know, is how, and by what stages, the physicist arrives at this astounding conclusion. If, as Prof. Einstein and his co-author claim, "Physics is a creation of the human mind, with freely invented ideas and concepts", it is this intellectual content which gives to physics one of its chief claims to cultural significance, and provides for the thoughtful non-technical reader his main source of interest in it. It is with this aspect of the subject that the authors are concerned in this very distinguished book.

The fact that they are "mainly concerned with the role of thoughts and ideas in the adventurous search for knowledge in the physical world" makes the task of the authors at the same time easier and more difficult. On one hand they can, and do, dispense with the experimental and mathematical scaffolding which is so terrifying to the lay reader —there is not a single mathematical equation in the whole book; on the other, the concepts of modern physics (though the authors describe them as "simple and natural") are by no means easy to grasp. The historical approach was obviously the one which offered the best chance of success, and, as the title implies, it is the historical method which the authors have chosen. "Our aim will be accomplished", they write, "if these pages give you some idea of the eternal struggle of the inventive human mind for a fuller understanding of the laws governing physical phenomena".

A fascinating story they make of it. The first chapter sketches the rise of the mechanical theory of the universe, from Galileo to Newton, from Newton to Joule and the kinetic theory of matter. The second chapter foreshadows difficulties for the hitherto triumphant mechanical view of Nature, in the discovery of the curious interrelation between the electric and magnetic fields, and in the wave theory of light. The difficulties were not felt very seriously at the time—in fact, the ether wave theory of light was regarded as one of the highest achievements of mechanical theory. Nevertheless, attempts to construct a reasonably acceptable model of the electromagnetic field, or to assign consistent mechanical properties to the luminiferous ether, all ended in failure. The conclusion is drawn that the trouble lies in the fundamental assumption that it is possible to explain all events in Nature from a mechanical point of view.

A new chapter opens with Faraday's discovery of electromagnetic induction, and Maxwell's conception of the electromagnetic nature of light. From this it is a short step to the problem of the ether drift and the decisive experiments of Michelson and Morley. The stage is now set for the introduction of the principle of relativity, an exposition of which, both in its restricted and in its general form, occupies the rest of the chapter. The story here reaches a true climax. The gathering difficulties; the search for a weak link in the apparently unbreakable logical chain of reasoning constituting the classical mechanical theory which nevertheless had led to predictions that experiment had failed to confirm; the final resolution of the difficulty in the principle of relativity is set forth with a genuine excitement, which betrays that the author was also an actor in the drama which he portrays. A final chapter on quanta reveals that "the eternal struggle" is far from having reached its final phase.

It will be evident from this brief synopsis that the authors have made no attempt to cover the

whole of physical theory—they have followed only one of its main channels. How far they have succeeded in their gallant attempt to make clear to the intelligent non-technical reader the fundamental conceptions of modern physics, the reader himself must decide. He may at any rate be assured that he is unlikely to find a more authoritative, lucid or genial guide. Although no previous technical knowledge is assumed, the book is not easy reading; indeed, no book of this kind can be that, unless its author has shirked the real difficulties of his task; and Prof. Einstein is not the man to shirk difficulty. What can be done by a singular lucidity of style, by apt illustration, and by occasional flashes of humour to smooth the path, the authors have done. The reader who pursues the path to its end will find that it brings him very near to the heart of physics. This is a book of real distinction, which no one interested in physical and philosophical ideas can afford to neglect.

J. A. CROWTHER.

Problems of National Survival

Political Arithmetic:
a Symposium of Population Studies. Edited by Lancelot Hogben. Pp. 531. (London: George Allen and Unwin, Ltd., 1938.) 30*s*. net.

"THE present volume sets forth some of the enquiries undertaken by the Department of Social Biology [of the London School of Economics and Political Science] during the Editor's tenure of office therein. . . . About half of the material is presented for the first time. Any profits arising from the sales will be devoted to the publication of other *factual* social studies."

The title of this collection of essays devoted to "realistic social enquiries" derives from the "Politicall Arithmitick" (1691) of William Petty, the "man of affairs" who was one of the founders of the Royal Society. The choice of title is appropriate in that, though probable (or standard ?) errors and correlation coefficients are given in places, quite elementary methods are still used, these being mainly discriminating tabulation and interpolation by proportional parts. The result, however, is an impressive contribution to the investigation of problems which are ever more urgently being thrust upon us.

The chapters are grouped under two headings: "The Survival Minimum" and "The Recruitment of Social Personnel". The thesis implied in the former is that "the rate of reproduction has sunk below the limit compatible with continued survival in many countries". This is established by studies of trends of fertility, mortality and nuptiality in Great Britain and in Australia; but the first chapter, by Dr. Kuczynski, deals with the international decline of fertility, while the last, by the same author, is a reprint from the *Annals of Eugenics* of a carefully documented and illuminating article, "British Demographers' Opinions on Fertility, 1660 to 1760". The second part is chiefly concerned with "a field of enquiry which has been conspicuously neglected" yet is less highly speculative, namely, in particular, the waste of ability in the denial of opportunities of study to many who would profit from further study, and conversely, due to the structure and working of English education. The relation of this wastage to parental occupation is also investigated. Further, the inducement we give to juveniles to take up unskilled work is exposed, and the differential fertility of skilled and unskilled wage-earners examined. A final chapter on an unrelated topic, the distribution of the blood-groups and its bearing on the concept of race, gives a very useful synopsis of the facts and a careful examination of what is involved in classification; this chapter also has a bibliography.

The general tone of the book suggests that it is but a preliminary attack on the problems to be studied; in fact, after the manner of the pioneers of the Royal Society with regard to British agriculture, a programme of "heads of enquiries" has been prepared with the help of a group of economists. The volume will certainly be convenient as a starting-point or a source of data, even for those who are using more advanced methods in the approach to population problems. A book like this should win recruits to these studies, and it would have been still more usable had it contained an index, or even a detailed table of contents. The excellent summaries at the end of most chapters do not compensate for this lack.

In the introduction to Part I, Prof. Hogben gives an outline of the tradition to which the work belongs, and incidentally makes an almost medievally vigorous attack on the scholastic tradition which he finds dominating the modern teaching of economics. It is in response to this tendency, he says, that Malthus "the phlogistonist of demography is far better known than Petty or Graunt".

We are attracted by "self-evident principles", rather than aware of the importance of definite data or of the possibilities of changing the facts of our social relations. This attitude is evidence of the stimulating, and possibly provocative, character of this work. Like medicine, economics must be indubitably freed from complete submission to merely deductive methods.

It is unfortunate, however, that in producing a book that is to be used, a little more care had not been given to ensure that the task of appreciating masses of data was made as little burdensome as possible. The difficulty in facing up to such appreciation may be essentially educational—how make it possible not to be oblivious to all save oversimplified ideas, such as those of Malthus? How encourage a vigorous openmindedness? For this reason it seems well to emphasize the obvious, that those who have been able to steep themselves in the details of such topics may be forgetful of how difficult it is for most who come fresh to them to get a satisfactory viewpoint.

Graphs are freely used in most of the chapters here, but it is not realized how depressing is the meticulous marking of all the graduations of a scale—indeed the over-detailed yet ambiguous marking of the class scale in Fig. 1 of page 126 raises doubt as to consistency with Table I of p. 108; the marking of a couple of salient graduations gets the range of variation most easily into perspective. The tables of gross reproductive rates, occupying pp. 54–59, would have been more readable if rows and columns had been interchanged. Comparison would have been facilitated had closely related maps been printed together on a folded sheet; and so on with such elementary matters.

But one wonders that, while the project of Petty for "A Dictionary of Sensible Words" is so strongly commended, this is neglected in a book which is in danger of being rather loosely knit. Progress in such studies has consisted in considerable degree in a refinement of the criteria to be applied, and reference to an authoritative list of the definitions of the various possible 'coefficients' would relieve the strain on those who have to form a fresh judgment as to which criteria are appropriate in particular cases. Some of the chapters too could with advantage be more fully documented; this can be remedied in a second edition. J. M.

Gas Attacks and Defence

Breathe Freely! the Truth about Poison Gas By Prof. James Kendall. Pp. xi+179. (London: G. Bell and Sons, Ltd., 1938.) 3*s*. 6*d*. net.

IN calculating the chances of air raids being carried out against Great Britain, Prof. Kendall thinks that Germany is the only nation that need be seriously considered, and it is on her policy that everything really depends. In his opinion, it is unlikely that there will be another war with that country in this generation, so that German air raids constitute, in the present state of Europe, nothing but an empty threat; but if they should come, and gas is used, it would be ineffective provided that adequate preparations are made and reasonable precautions are taken against it.

Prof. Kendall says that chemists are absolutely confident that no 'super gas' has been found, and he thinks that it is most unlikely that since the Great War poison gases have been discovered which are markedly superior to phosgene as an offensive weapon or to mustard gas as a defensive one. In fact, gas is only likely to be used in future if one side has a desperate reason for its employment and when effective retaliation is either impossible or likely to be impracticable owing to the demoralization caused. Germany no longer enjoys a monopoly in chemical manufacture, so that she can never again depend on a six-months start over her opponents. If she failed after taking this step, she would be shown no mercy a second time and would be ruled with a rod of iron for generations.

The author refers at some length to the scaremongers and he exposes their extravagances: "It is all so pathetic and at the same time such arrant rot"; and he even comments on the disproportionate effort expended by the Home Office on anti-gas instruction in its Air Raid Precautions Handbooks. This seems a little unreasonable, because there was an obvious need for instructing an ignorant and apathetic public. It was only by stressing the danger—within limits—that an effect could be produced, and once this danger was realized adequate preparations would do much to render gas ineffective, so that the inclination to use it would be discouraged, and one at least of the risks of an air raid would be eliminated.

While instructed readers will be in general agreement with the author in the main purpose of this book, they will not so readily accept his

conclusions when he makes excursions into regions outside his own province. For example, with the experience of the prolonged and dangerous situation caused by a civil war in Spain—a second-class country—is a general European war within the next few years "exceedingly improbable"? Prof. Kendall says that barking dogs never bite, but when good faith is lacking, armaments are mounting, militarism is being inculcated in the whole youth of the totalitarian States, and recent aggressive steps have met with such astonishing success, it seems more probable that the next moves are merely a matter of opportunity and careful timing; and that Great Britain would be drawn, however unwillingly, into any conflict between first-class Powers, regardless of the apparent limitations of its existing treaty engagements.

Does the use of gas merely involve a prolongation of hostilities? If chemical warfare had continued into 1919, would the main bodies of troops have taken shelter in huge dug-outs while squads of men relieved each other at frequent intervals in the exhausting task of decontaminating scores of square miles of territory? Are the huge new blocks of flats in Germany much more vulnerable to incendiary bombs than the isolated houses which predominate in British towns? Were the casualties sustained by the German troops caused by the imperfection of what their commanders termed their "iron gas discipline", or rather by the various weaknesses of human nature which would be displayed to a much more pronounced extent by a civil population?

However, these expressions of opinion are not the primary object of the author, which is to examine in an impartial way the possible use of gas and its probable effects in an air raid. Even if he has told us nothing new, he has succeeded in placing the actual facts before the public in proper perspective, so that "the way to avoid Bedlam is not to go insane in advance".

C. H. FOULKES.

Extinct Mammals of the Western Hemisphere

A History of Land Mammals of the Western Hemisphere

By Prof. William Berryman Scott. Revised edition, rewritten throughout. Pp. xiv+786. (New York: The Macmillan Co., 1937.) 32*s*. net.

A PERIOD of a quarter of a century has elapsed since the first appearance of Prof. W. B. Scott's admirable account of the mammals of the western hemisphere. The new edition that has just appeared gives a measure of the increase in our knowledge of extinct mammals during this time, the result of praiseworthy activity on the part of many museums of the United States and Canada. This increase has necessitated so much revision and rewriting that, with the exception of the title and a couple of chapters, the work is more properly to be described as a new book than as a new edition. There are also more than a hundred additional figures, including many new restorations.

The author in the preface to his first edition said that so rapid was the uninterrupted course of discovery that parts of the text became antiquated while in the press. The same statement could still be repeated to account for the absence of notice of the late W. D. Matthews' work on the fundamentally important Palæocene fauna of New Mexico which, published last year, appeared too late for incorporation. On the other hand, most new results or discoveries of scientific interest that were available seem to have found a place and their first home in a general text-book. The skull of *Thylacosmilus*, a sabre-toothed marsupial which, when compared with the totally unrelated sabre-toothed tiger *Eusmilus*, gives as striking an instance of convergent and highly specialized adaptation as one could hope for; and, to quote only one more example out of many, the radiation into numerous and bizarre forms of antler in the prong-horn and other deer families described by Child Frick, are examples of recent discoveries.

The author also in his preface states that his book is written for the "non-professional" and that "perhaps it is unjustifiable optimism to assume the existence of a body of readers of this subject", but that he hopes that nevertheless they are to be found. It is much to be hoped that this book itself will create such a body, once they are introduced to this fascinating subject of mammalian palæontology. The first four chapters are introductory and are by no means unduly technical, so that the "non-professional" reader should be able to continue to the end with increasing interest. It is, however, the professional palæontologists, who, knowing the difficulties that have to be surmounted in the production of a summary account of so wide a field, will be the ones that feel not only interest but also admiration for Prof. Scott's achievement.

The Linnean Society

A History of the Linnean Society of London By Lieut.-Colonel A. T. Gage. Pp. 175 + 11 plates. (London: Taylor and Francis, 1938.) 5*s*.

THE hundred and fiftieth anniversary of the founding of the Linnean Society of London, which is being celebrated on May 24–27, is a very suitable occasion for the publication of its history. Several previous attempts to compile the history of the Society had been made, but they did not come to fruition. In Colonel Gage, the Society was fortunate in finding not only an energetic and faithful historian, but also one whose intimate knowledge of the Society and its archives rendered him peculiarly fit to put on record the growth and development of the Society and the vicissitudes through which it has passed.

The hundred and fiftieth anniversary is an occasion for the fellows to praise great men and the fathers that begat the Society, that triumvirate James Edward Smith, who had purchased the Linnean collections and books, Samuel Goodenough and Thomas Marsham, for many years president, treasurer and secretary of the Society respectively. But just as many infants pass through very critical periods in their lives, so the Linnean Society, after some years of initial prosperity, found its meetings becoming poorly attended and the subscriptions of its fellows less regularly paid. To crown these difficulties, the president, Sir James E. Smith, moved from London to Norwich in 1796, taking the Linnean collections and books with him. This was like removing the Ark of the Covenant from the Temple. To counteract these difficulties, some active fellows urged the obtaining of a charter for the Society, and this display of energy as well as the enhanced prestige which the Society obtained thereby, had the desired effect, and by the beginning of the nineteenth century the Society had attracted more than two hundred members.

Smith, though absent from London, remained president of the Society for forty years, until his death in 1828, when his executors offered to sell to the Society the collections and library of Linnæus, together with other specimens and books acquired by Smith, for the sum of £5,000. With great difficulty, but with superb courage, the Society managed by various expedients to raise the necessary funds and thus regained possession of the collections, the free use of which, while their president lived in London, had formed a centre of attraction for the fellows and had inspired the name of the Society.

There were other difficult times to live through. The hiving off (in 1826) of the Zoological Society no doubt took away some members and prevented some potential ones from joining, though the main object of the new Society was the maintenance of a Zoological Garden rather than the furtherance of scientific zoology. This is indicated by the election of Thomas Bell, professor of zoology at King's College, to the presidency of the Linnean Society in 1853, though he was for eleven years a vice-president of the Zoological Society. Incidentally, it may be mentioned that he was one of the most active presidents the Society has ever had. He introduced the idea of annual presidential addresses and also the discussion of papers after they had been read at the general meetings.

Other critical periods were due to internal dissention on questions of procedure and some on policy, as when the admission of women to the Society was being urged and ultimately agreed upon in 1904. In connexion with this innovation, Colonel Gage shows conclusively that it was not made, as has been suggested, with a view of improving the finances of the Society.

The continued prosperity of the Society may be summed up in the words, slightly altered, which the president Carruthers used when referring to the centenary meeting. "The story of the Linnean Society during the last 100 years is the history of Biology". The names of such leading fellows as James Edward Smith, Robert Brown, Bentham and Hooker, Wallace and Darwin, and all they stood for, more than justify the existence of the Society. Its future prosperity and usefulness depend upon its power to adapt itself to new conditions and to the further development of the biological sciences. Colonel Gage does not merely praise the past, he is rightly critical of many actions of former presidents and councils, and future members of the latter will do well to study the history now under review. It may enable them to avoid possible difficulties, and in addition they will find much valuable information in the later chapters of the history, which deal with the publications, the library and the finances of the Society.

The future fellows of the Society, like the present ones, will, we are sure, be deeply grateful to Colonel Gage for his careful and painstaking history, carried out with courageous determination in spite of considerable set-backs due to ill-health. It will remain an enduring memorial of the handiwork of a faithful and discerning fellow of the Society.

Reports of the Progress of Applied Chemistry
Issued by the Society of Chemical Industry. Vol. 22. Pp. 818. (London: Society of Chemical Industry, 1937.) n.p.

THIS annual volume fully maintains the high standard which chemists and chemical manufacturers have learned to expect. It is presented in the traditional form of sectional reviews on the principal branches of applied chemistry, fully documented by reference to the relevant technical literature and patent specifications, and to abstracts thereof published by the Bureau of Chemical and Physiological Abstracts. The series is therefore almost indispensable to anyone taking an active interest either in the progress of chemistry or in the advancement of any branch of industry which involves the use of chemical operations, a knowledge of the chemical composition or behaviour of materials, or the employment of chemists for control or research. Further, it is a convenient guide-book in the hands of those who wish merely to take a bird's-eye view of modern technology in its chemical aspects.

The present issue deals, *inter alia*, with fuels, with dyes and textiles; with paper, glass, cement, steel, drugs, oils, paints, rubber, leather, sugar, and soil; with foods and water; with electrochemistry and photography. Explosives, which are treated biennially, do not appear in this volume. The section dealing with bleaching, dyeing, printing, and finishing has this year been incorporated with that on fibres, textiles, and cellulose, the combined chapter occupying between eighty and ninety pages.

Name and subject indexes are provided.

A. A. E.

Fermente, Hormone, Vitamine:
und die Beziehungen dieser Wirkstoffe zueinander. Von Dr. Robert Ammon und Dr. Wilhelm Dirscherl. Pp. xvi+451. (Leipzig: S. Hirzel, 1938.) 30 gold marks.

EULER has classified the hormones and vitamins together as "ergones", and has laid stress on the fact that ergones may act as coferments. The best examples are vitamins B_1 and B_2, which are important parts of the molecules of cocarboxylase and Warburg's yellow ferment. It seems probable that many ergones may act by influencing enzymes. The authors of the present book class together as "ergines" all the organic substances which act in small doses—enzymes, hormones and vitamins. These groups interact in many ways and are conveniently considered together.

The book is written from the point of view of the biochemist, but clinical observations are also discussed. Authorities are not quoted with full references; but the author's name and the year are usually mentioned, and there should be no serious difficulty in tracing the originals. The book contains much information and is usually fairly accurate, but uncritical. The vasodilator substances which are found in tissue extracts are included as *Gewebshormone*. The work of Rowntree and his collaborators on the thymus is not mentioned.

Land of Ice and Fire
By Hans Wilhelmsson Ahlmann. Pp. xiii+271+16 plates. (London: Kegan Paul and Co., Ltd., 1938.) 12*s*. 6*d*. net.

THE Vatna Jökull of Iceland, with an area of well over three thousand square miles, is larger than any other glacier in Europe. It is rugged, crevassed and even chaotic in parts, and is associated with an undue share of fog, wind, snow and rain. The heavy .ion and the extensive ablation make it an area of important investigation into the relations between the growth and wastage of glaciers. From time to time it has been crossed, notably in 1932, when the Cambridge expedition, which is not mentioned in this book, made a double traverse.

Prof. Ahlmann's Swedo-Icelandic expedition of 1936 was designed to penetrate the eastern interior of the ice sheet, chiefly in order to measure growth and wastage. This entailed the digging of pits in which the thickness of each year's accretion could be seen and the planting of surface posts against which wastage could be noted. It is not an easy area in which to travel, and in Prof. Ahlmann's book the task loses nothing of its reputation for difficulty, but there were some fine days and on the whole the expedition achieved its aims, though this book does little more than touch on the conclusions.

However, the work of the expedition was not confined to Vatna Jökull. Several other parts of Iceland were visited, and there is much of interest in the account of peasant life in Iceland and the struggle with adverse soil and climate that Icelandic agriculture and stock raising have to face. These chapters give a good picture of modern Iceland. It is a pity that the translation from the Swedish is somewhat laboured and in places lacking in idiomatic English usage. The photographic illustrations are excellent, and the map, though rather meagre, serves its purpose.

R. N. R. B.

The Dissection and Study of the Sheep's Brain:
as an Introduction to the Study of the Human Brain. By James Wilkie. (Oxford Medical Publications.) Pp. xvi+95. (London: Oxford University Press, 1937.) 6*s*. net.

THE object of this little work, as stated in the preface by the author, who is attached to the department of biology at Guy's Hospital Medical School, is "to enable the student of comparative anatomy to use the text books of human anatomy; and to help the medical student who wishes to improve his knowledge of the anatomy of the brain, or to begin the study of the human brain with a certain background of comparative anatomy".

The book is divided into five chapters, devoted respectively to removal of the brain, its general anatomy, the first dissection in which a general study is made of the cerebral hemispheres, cerebellum and brain stem, the second dissection, and hand sections.

The text is liberally interspersed with diagrams of the human brain as well as that of the sheep, and is provided with a full index.

Disorderly Molecules and Refrigerating Engineering*

THE many facets of the jewel of truth are only too often exposed in a sequence that is bewildering but, even so, it is not often that succeeding facets reflect such dis... beams as at first sight to seem to demand the ascription of conflicting virtues to the body of the jewel behind. Sir William Bragg, giving the James Forrest Lecture last year, dealt with the orderly arrangement of the atoms within crystals: Sir Frank Smith, the lecturer for this year, was concerned to demonstrate how the disorderly or random nature of the molecular motions within a substance make it possible for chemical actions on one hand, and the refrigeration industry on the other hand, to exist.

Accepting the identity of the motion of molecules with heat and the corollary that the temperature of a body is a measure of the intensity of their translatory movement, Sir Frank pointed out, in illustration, that if at a given moment the molecules in the air in the lecture theatre were all to be in simultaneous collision with each other, the temperature of the air would drop to absolute zero. Incidentally, under the influence of the gravitational pull, they would fall to the floor. With his assertion that the attainment of very low temperatures has been one of the great scientific advances in recent years, few—and certainly no engineer—would disagree: the knowledge gained of the motion of liquid molecules and of the evaporation of liquids has found widespread application at more elevated temperatures in many fields, of which refrigerating engineering in particular is the obvious example.

Sir Frank Smith purposely refrained from embarking on a historical résumé of low-temperature work, and from employing a mathematical treatment or the empiricisms of Boyle's Law or its various refinements to explain the phenomena he was considering. Instead, he tried to make his approach solely from considerations of the general nature of atoms and molecules, their movements and their interactions. Assuming only that atoms consist of charged nuclei surrounded by electron shells, he proceeded to consider in general terms what might be expected to happen in a collision between two similar atoms. The collision would inevitably set up some, probably electromagnetic, stress and if the collision were such that, for a moment of time, both were brought to a standstill, then the kinetic energies of each of the atoms would disappear and the electromagnetic stresses would simultaneously reach their maximum values. Afterwards, the stressed systems would cause repulsion to take place and the atoms would then move away from one another. However, in addition to this force of repulsion effective at distances comparable with molecular diameters, there is a general force of attraction between atoms and molecules which he suggested might be of the nature of electromagnetic induction. These forces and their resultant were shown graphically, plotting nuclear distances against the force exerted, and it was shown that the curve embraces the solid, liquid and gaseous states and that it indicates that increase in the temperature of a substance will cause expansion. The slope of the curve at zero force is a measure of the elasticity of the material, and the maximum value of the 'resultant' force indicates the maximum force which can be applied without rupture to the substance in the solid form. The value of the nuclear distance at this point represents the ideal elastic limit of the substance; but, in practice, factors introduced by the presence of impurities or other causes modify the attainable elastic limit and rupturing force.

Attention was then directed to a consideration of the Joule-Thomson effect. In every gas there are two effects on expansion, one tending to lower and the other to raise the temperature. The cooling effect depends on the degree of separation of the molecules, and the heating effect depends on molecular collisions, increasing with increase of temperature. At sufficiently high temperatures the net effect is to produce a rise in temperature, at the inversion point there is no change and below it there is a fall in temperature on expansion. Liquefaction of air by compression alone is impossible at ordinary temperatures, and preliminary cooling to below the critical temperature is necessary, although by the use of a cold regenerator or heat-exchanger the need for very high pressures and very low initial temperatures is made unnecessary.

After a brief explanation of the Claude expansion method of refrigeration, Sir Frank Smith passed to the production of relatively pure atmospheric gases by rectification (or the separation of the various constituents of liquid air by making use of their different boiling points) and indicated various commercial uses of the gases so obtained. The same method is applied to water gas and coke-

* Account of the James Forrest Lecture delivered by Sir Frank Smith, K.C.B., F.R.S., before the Institution of Civil Engineers on May 3.

oven gas and can be, and sometimes is, used commercially to produce relatively pure hydrogen.

These methods have been used under suitable conditions to attain temperatures less than 1° K., but, while it is admitted that it is most improbable that the absolute zero of temperature will ever be reached, advantage has been taken of the magnetic properties of matter to approach it very closely. The phenomena we know as magnetism are due to the existence of atomic magnetic dipoles which, in a magnetic field, are pulled in the direction of that field. The motion of the atoms which is associated with heat resists this pull, and so the resultant magnetic field depends on the temperature as well as on the intensity of the applied magnetic field: the higher the temperature, the less the magnetization. In general, the magnetic dipoles become arranged in orderly fashion at comparatively high temperatures, but there are a few substances, such as iron ammonium alum, in which random orientation still exists at very low temperatures. When such substances are at the lowest temperature attainable by the methods already described, application of a magnetic field modifies the dipole directions and heat is developed. This heat is slowly absorbed by the cold surrounding surfaces, and when the original low temperature has been restored the magnetic field is removed. The dipoles then tend to revert to their previous random orientation and, in so doing, absorb heat, so that the temperature drops. By making use of this effect, a temperature as low as 0·003° K. has been reached.

Turning back from very low temperatures, a pause was made to consider in some detail the mechanism of the evaporation of liquids. Maxwell's law of distribution shows that at any time some molecules are moving with a velocity ten or twenty times greater than that of others. Such fast-moving molecules are the ones which escape from a liquid, and in so doing they tend to lower the average velocity, and hence the temperature, of the remainder. Equally, it is the fast-moving molecules of vapour which tend to re-enter the liquid and increase the average velocity of the molecules there. This counter-effect produces a heating of the liquid. The actual temperature of the liquid will thus be determined by an algebraic summation of these two effects and in order, on balance, to produce cooling it is necessary to eliminate the 'counter-effect' by removing the molecules of vapour as soon as they leave the liquid. By this device, quite low temperatures may be attained.

This effect is the basis of most modern commercial refrigeration machines. Even a century ago, Faraday reached a temperature of 160° K. by evaporating a liquid under an air-pump and to-day, by using helium, a temperature of 1° K. may be attained. Present refrigerating practice utilizes substances (principally ammonia and carbon dioxide) which are vapours at ordinary temperatures and pressures and can be liquefied by subjection to increase of pressure but without preliminary cooling: atmospheric temperature is well below their critical temperatures. It is necessary, therefore, that any pumping mechanism should not only exhaust the vapours from the upper surface of the liquid but should also be able to compress them. When compressed, the gas molecules are brought closer together and the heat produced is extracted by cold water surrounding the compression chamber. The attractive force between the gas molecules becomes greater and greater as the pressure is increased and eventually the substance liquefies. This cold liquid is passed through an expansion- or throttling-valve, and at the same time the pressure to which the liquid is subjected on emergence from the valve is so reduced by suction that the liquid boils. Brine which is circulating around this chamber is therefore cooled and then passes through pipes and tanks as may be desired. It is part of the process to collect the vapours removed from the expansion chamber and to recompress them so that they undergo a continuous process of compression and expansion, liquefaction and evaporization.

Refrigeration engineering now finds application not only to the production of ice and, extensively, to the transport and storage of food of many kinds, but also to the cold storage of bulbs, the conditioning of air for public rooms, cold depositories for furs, carpets and many textile goods, the production of ice in skating-rinks and the freezing of ground for shaft-sinking and tunnelling in water-logged strata.

Whereas, sixty years ago, there was no refrigerating machine and certainly no cold storage provided in ships, to-day the refrigerated space in ships bringing food to Great Britain alone amounts to not less than 100 million cubic feet, equivalent—as it was rather strikingly put—to a single cold store as wide as Victoria Street, London, 20 feet high and 13 miles long. No fewer than thirty countries contribute to our food supply by the help of refrigeration, and it may truly be said that our food can now be practically independent of the seasons.

In very low temperature work, however, progress has not been so rapid, and Sir Frank Smith confessed to a hope that engineers might be persuaded to take an active interest in the problems involved, and commended to his audience the work in progress in the laboratories at both Oxford and Cambridge.

H. W.

Some Aspects of Chemical Kinetics in Gaseous Reactions*

By Dr. H. W. Melville

SINCE the realization, half a century ago, that free energy furnishes an exact criterion for the direction in which chemical changes occur, the control of such processes to the desired end-point is easily accomplished. Indeed this is one of the main functions of chemical thermodynamics. That knowledge, however, provides absolutely no information about the nature and speed of the interactions between molecules. Moreover, in view of the fact that the control of reaction rate is not less important than the production of the specified products, an understanding of the mechanism of reaction is an essential complement to a knowledge of free energy change.

Although chemical kinetics and thermodynamics both came into being practically simultaneously, the latter science soon forged ahead. The reason is not far to seek. Most reactions were studied in the liquid phase, in spite of the fact that there was and still is no satisfactory kinetic theory of liquids. But when an intensive study of gas reactions was commenced about ten years ago, aided by the kinetic theory of gases, material progress soon became evident. Although the subject is still in active state of development[1], it would appear that the broad principles are now firmly established.

No matter how complicated a gaseous reaction may be, it consists essentially of a very few collision processes. For purposes of classification four such processes may be distinguished, namely, unimolecular, bimolecular, trimolecular reactions and collisions in which there is a specific transfer of large amounts of energy between dissimilar molecules. The relationship between the absolute velocity of these reactions and the energy changes involved is now sufficiently well understood to enable predictions to be made regarding new reactions falling into one of the several classes. Thus by suitably altering the conditions under which the reaction takes place, it is possible to isolate and identify the elementary processes, so that some conclusions may be drawn about the chemical constitution of the entities taking part. The greater volume of current work in kinetics is directed towards this goal, thereby making the subject extensive. Only a few of the more recent developments can be mentioned in this article.

One of the most important developments is the use of isotopes of the common elements in tackling certain problems unassailable by conventional methods. For example, if phosphine is irradiated with ultraviolet light, only one molecule is decomposed for every two quanta absorbed, although the absorption spectrum of the molecule indicates that each quantum on absorption dissociates the molecule thus: $PH_3 \rightarrow PH_2 + H$. It was suspected that the recombination $PH_2 + H \rightarrow PH_3$ was responsible for the low quantum yield. This was at once proved[2] by adding deuterium to the phosphine, when deuterium atoms are produced by the reaction $H + D_2 \rightarrow HD + D$, followed by $D + PH_3 \rightarrow PH_2D$, the phosphine thus becoming 'heavy'. The question then arises about the fate of the PH_2 radical. It may decompose to a P atom and an H_2 molecule or it may interact with another of its kind, thus $H_2P + PH_2 \rightarrow P_2 + 2H_2$. If a mixture of PH_3 and PD_3 is decomposed, H_2 and D_2 molecules will be produced in the first mechanism, whereas in the second H_2, HD and D_2 molecules will appear. In point of fact HD molecules are present in their equilibrium amount in the hydrogen gas. Similar experiments give a clue to the mechanism of the photodecomposition of ammonia.

Likewise the possibility of following exchange reactions, such as the rate of formation of HD molecules from $H_2 - D_2$ mixtures or the rate of conversion of para to normal hydrogen, provides important evidence about the nature of the rate-determining step in heterogeneous reactions involving hydrogenation and dehydrogenation. For example[3], in the hydrogenation of ethylene to ethane on a nickel catalyst, a purely kinetic analysis cannot provide any indication whether the dissociation of hydrogen is the rate-determining step. Actually, in absence of ethylene the hydrogen is dissociated far faster than the ethylene is hydrogenated, whereas in presence of ethylene at temperatures around 100° C., dissociation is inhibited altogether. In other words, the hydrogen probably gains access to those parts of the nickel surface not covered with ethylene, is dissociated there and immediately hydrogenates the ethylene. At higher temperatures, the surface becomes denuded of ethylene, when dissociation of hydrogen proceeds more quickly than hydrogenation, owing to the fact that hydrogen atoms then have an opportunity of recombining and so returning to the gas phase. Again, in the exchange reaction, $D_2 + CH_4 \rightarrow CH_3D + HD$[4], a similar technique showed that the dissociation of hydrogen was not

*Substance of a series of afternoon lectures delivered at the Royal Institution on February 17 and 24 and March 3.

the rate-determining step. The following alternatives are open: (*a*) the reaction of a D atom with a methane molecule adsorbed as such, $D + CH_4(ads.) \rightarrow CH_3D + H$, or (*b*) the dissociation of methane followed by the reaction $CH_3 + D \rightarrow CH_3D$. The decision in favour of the second alternative was reached by measuring the rate of interaction of CH_4 and CD_4 molecules to give methanes of intermediate D-content, CH_3D, CH_2D_2, CHD_3, when it was found that the latter reaction went at approximately the same speed as the exchange reaction.

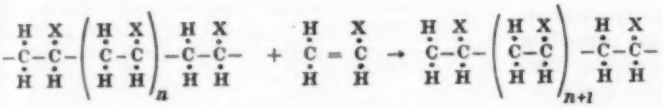
The homogeneous exchange reactions of deuterium atoms with hydrides have also brought under discussion a number of points regarding interactions in simple systems. Here there are two possibilities: (*a*) a simple exchange reaction, $D + HX \rightarrow DX + H$ or (*b*) a dehydrogenation reaction $D + HX \rightarrow HD + X$. Examples of both types are known and appear to fall into a general classification[3]. The simple hydrides of the fourth group are all dehydrogenated, namely, CH_4, SiH_4, GeH_4, whereas NH_3, PH_3, OH_2 and probably ClH exchange atoms without dehydrogenation. With the more complicated hydrides such as C_2H_6, Si_2H_6, N_2H_4, decomposition to simpler fragments CH_4, NH_2 appears to be the general rule. Recent theories[1] of reaction rates have shown that the activation energy required is controlled by the dissociation energies of reactants and products, the internuclear distances, the anharmonic constants of the molecular vibrations and the ratio of Coulombic to exchange forces between the atoms. Hence it is extremely difficult even to predict whether exchange or dehydrogenation will take place in any given instance. The behaviour of CH_4 on one hand and NH_3 on the other might, however, be accounted for in the following way. NH_3 may form a complex NH_3D, such as is supposed to exist in ammonium amalgam. This complex, although of transitory existence, as is known from the fact that ammonia has no influence in reducing the stationary concentration of atomic hydrogen, afterwards decomposes, when any one of the four bonds may break. With methane there is no possibility of forming such a complex; hence if the deuterium atom is to react at all, it can only do so by abstracting a hydrogen atom from the molecule.

It is to be emphasized that the activation energies of the exchange reactions range from about 7 to 14 k.cal., whereas the energy required to sever a hydrogen bond in the hydride is of the order of 100 k.cal. The difference in the two values must be ascribed to what has been termed 'driving force' in chemical reactions[4]. Consider the simple interchange $D + XH \rightarrow DX + H$, then the maximum possible activation energy, that is, the potential energy which the system has to acquire, is the energy dissociation of HX. When a D atom is pushed up towards HX, repulsive forces come into play while there is a simultaneous increase in nuclear separation of HX. On continuing the process, however, a stage or transition state is reached when the attraction between X and D is equal to that between X and H. The system may then revert to its original or final state without having to acquire further potential energy. The rate of this latter process, multiplied by the number of systems in the transition state, determines the rate of reaction. Although the state is essentially one of unstable equilibrium, many attempts[1] have recently been made to compute by the methods of statistical mechanics the concentration of systems in this state. While the results are often roughly in quantitative agreement with experimental measurements, it seems that, owing to lack of precise data, the method is not more accurate than that of the classical collision theory of reactions. What it does provide, however, is a picture of the more intimate details of a chemically effective collision—a process necessarily neglected by the older theory.

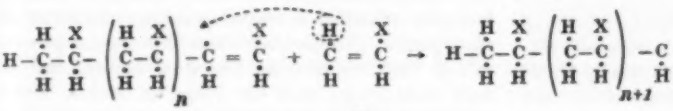
Another important outcome of the study of isotopic reactions is the estimation of the part played by the half quantum of residual vibrational energy postulated by quantum theory. All reactions of deuterides are slower than the corresponding changes with hydrides, owing mainly to the lower energy of activation of the latter reaction[5]. Since the vibrations of such molecules are not appreciably excited at reaction temperatures—20°–600° C.—the vibrational energy of molecules consists only of residual energy. In deuterides the vibration frequency is lower than that in hydrides, hence the residual energy is lower. Consequently, in order that the system should reach the transition state, a larger energy is required for the deuterium reaction with a corresponding decrease in reaction velocity. Again, theory and experiment are in qualitative agreement, although an increase in accuracy on both sides is to be desired.

On the more strictly classical side, methods of reaction kinetics are being applied to study polymerization reactions in the gas phase. Suitable examples are difficult to find. In fact there are scarcely any true thermal gas polymerizations known, and it is consequently necessary to start the reaction catalytically or photochemically. At present the latter method is the more useful and has been employed in investigating the mode of growth of polymers from ethylene derivatives. The conditions under which polymerization occurs are well defined. Ethylene and all monosubstituted ethylenes of the general formula $CH_2 = CHX$, where X may be halogen, C_6H_5, CN,

$COOCH_3$, etc., polymerize. Likewise, disubstituted derivatives $CH_2 = CXY$, where X is similar to or identical with Y also aggregate readily, but if X or Y is transferred to the other carbon atom, thus $CHX = CHY$, polymerization is completely prevented. For example, methyl methacrylate $CH_2 = C.(CH)_3COOCH_3$ readily polymerizes; methyl crotonate refuses to do so[7]. The precise explanation of these facts has not yet been discovered. When polymerization is initiated photochemically, the radiation invariably enters the molecule by the X or the Y group and thereby renders the double bond reactive. If a short enough wave-length is employed—around 2000 A.—where the double bond itself exhibits absorption, then the energy of the quantum is so big that the molecule is often broken up and very little polymerization can be detected. The nature of the initiation process also raises the question of the mechanism of growth. In view of the fact that one quantum will polymerize, in some instances, a thousand molecules of monomer, it is evident that, once a molecule is activated, monomer molecules add on comparatively readily. The question which arises is whether the growth occurs through (*a*) the intermediacy of a free radical, or (*b*) by the so-called double bond mechanism.



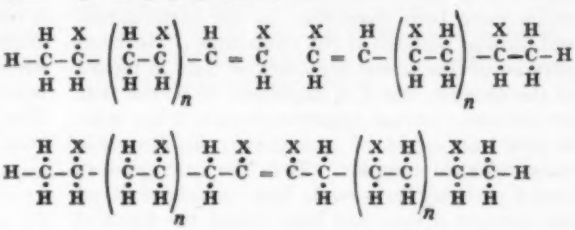
(*a*)



(*b*)

A method of discriminating between the two mechanisms is by intentionally making a free radical by generating, photochemically, H atoms or methyl radicals. These react with the monomer to form $CH_2 - \dot{C}(H) - \dot{C}(X) -$. With some molecules, for example, methyl methacrylate, $CH_2 = C.(CH)_3.COOCH_3$, the normal photopolymerization and the radical-induced polymerization have quite different characteristics. In the radical polymerization, the reaction occurs wholly in the gas at a rate proportional to the square root of the intensity of the light and is completed within 10^{-2} sec. when two growing polymers come into collision. On the other hand, in the normal reaction the polymerization certainly starts in the gas phase but continues on the walls of the reaction vessel, when the light is switched off, for hours and even days. The maximum dark rate is proportional to the area of the vessel illuminated and is independent of the intensity of illumination. There can therefore be no doubt that the normal growth occurs by the double bond mechanism.

This does not explain why the molecule keeps on growing indefinitely. An explanation for the reason of this behaviour is obtained when methyl acrylate is examined. This polymer does not grow indefinitely. It dies soon after polymerization has proceeded to some considerable extent in the gas phase. Its death is due to a collision between two growing polymers thus:



involving the simultaneous migration of two hydrogen atoms. If two methacrylate polymers were to interact in this way, two methyl groups would have to migrate—a rather improbable process. The long life of the methacrylate polymers is apparently due to the immobility of a methyl group. The methacrylate polymer can, however, be stopped growing by hydrogenating the end of the molecule by atomic hydrogen.

Kinetic methods also permit of the determination of the molecular weight of a polymer produced photochemically. The obvious method of computing the molecular weight by multiplying the number of molecules polymerized per quantum absorbed by the molecular weight of the monomer is based on the unjustifiable assumption that each quantum absorbed starts off a chain. A more satisfactory method consists in discovering a suitable inhibitor, one molecule of which (in the inhibited photo-reaction) adds on to each chain started, thereby stopping growth. The ratio of molecules polymerized to molecules of inhibitor consumed then gives the chain length of the inhibited and therefore that of the normal reaction. Butadiene has been used in this way for methyl acrylate polymers.

The question of the estimation of the cross-linking of polymer chains is still an outstanding problem in this branch of the subject, as the method hitherto available for computing branching in ordinary explosive chain reactions is not applicable in the present instance.

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The Spring Drought in the British Isles

By E. G. Bilham

THE spring of 1938 has been rendered memorable in the British Isles by a remarkable sequence of meteorological events, the results of which have been disastrous to the horticultural and farming sections of the community. The main purpose of this article is to furnish data in regard to the drought, but it is important to realize that the deficiency of rain, unprecedented as it has been, is only one aspect of a singularly unfavourable meteorological complex. Thus the fruit growers would probably have made little complaint about the drought if they had been spared the frosts of April and early May, following upon an exceptionally mild March in which all vegetation made rapid growth. Incidentally, March and April have provided an example of the untrustworthiness of the generalization that the rainfall of the British Isles is related to the direction of the prevailing wind; in March we had a great shortage of rainfall and the winds were persistently south-westerly; in April we also had a very dry month and the winds were persistently north-easterly.

The period of exceptional rainfall deficiency began in February, following upon a wet January. In February pressure exceeded the normal by about ten millibars in all parts of the British Isles, and as is usual when anticyclonic conditions predominate, rainfall was markedly below normal, though there was an excess in the west and north-west of Scotland, and in small areas in Yorkshire and south-west Ireland. At Kew Observatory the total fall for the month was only 0·31 inch, or 20 per cent of the normal. The general fall over England and Wales, deduced from the observations at a selection of representative stations, was 1·34 inches, or 52 per cent of the normal. For Scotland, the percentage was 80, for Ireland 66, and for the British Isles as a whole, 62.

The corresponding values for March and April, and for the whole period February to April, are included in the accompanying table. It will be seen that March was very decidedly drier than February in England and Wales, though Scotland had nearly the normal rainfall. The drought was particularly severe in the western Midlands, and at Ross-on-Wye the total for the month was no more than 0·02 inch, the smallest total for March in records going back to 1859. On the other hand, exceptionally heavy rains occurred in parts of western Scotland. At Loan (Loch Quoich), in Inverness-shire, the total for March was no less than 50·03 inches, one of the largest monthly totals ever recorded anywhere in the British Isles.

GENERAL RAINFALL OF THE BRITISH ISLES, FEBRUARY TO APRIL, 1938

	England and Wales	Scotland	Ireland	British Isles
February	1·34 in.	3·34 in.	2·33 in.	2·02 in.
Per cent of normal	52	80	66	62
March	0·72 in.	3·93 in.	2·18 in.	1·67 in.
Per cent of normal	27	97	65	52
April	0·28 in.	1·02 in.	0·20 in.	0·43 in.
Per cent of normal	13	34	7	17
Total	2·34 in.	8·29 in.	4·71 in.	4·12 in.
Per cent of normal	32	74	49	45

Although the total fall for February and March was exceptionally small in many areas, the drought had not achieved a record-breaking character at that stage. For England and Wales, the general fall in the two months was 2·06 inches, and we only have to go back ten years to 1929 to find a substantially smaller fall, 1·60 inch, in the same two months. April, however, brought a very great and general intensification of the shortage. With a general fall of no more than 0·43 inch over the British Isles as a whole, it was not only the driest April in our annals, but also the driest month of any name of which we possess records. The general rainfall was, however, only slightly exceeded in February 1891, June 1925 and February 1932.

For England and Wales the percentage of normal was 13. So far as our information goes, only three previous Aprils have yielded percentages less than twenty; namely, those of 1817 (16 per cent), 1893 (18 per cent) and 1912 (15 per cent). April 1893 was remarkable for having yielded no rainfall at all over a large area in south-east England. April 1938 achieved that distinction at

only a few stations; the main feature was the widespread distribution of the drought. The very small percentage of normal, 7, in Ireland is particularly striking. No previous April has produced anything like such a deficiency in that area.

The total rainfall of the three months February to April 1938 amounted in England and Wales to 2·34 inches, or 32 per cent of the normal. No previous combination of three successive months has yielded so small a total since comparable evaluations began in the year 1870. It is possible to carry the comparison back for more than another century, with some approach to certainty, by referring to a series of estimates of general rainfall percentages by Dr. J. Glasspoole and Miss F. J. Nicholas published in *British Rainfall*, 1931. From these estimates it appears that a comparable period occurred in 1785, when the combined total for February to April amounted to about 2·1 inches. No more recent sequence of three months has been drier than that experienced this year.

To the natural question "why?", we can only reply at the moment that the dry weather was due to an exceptional persistence of anticyclonic conditions, combined in April with a prevalence of north-easterly winds. At the present stage of our knowledge of the causes of seasonal weather changes, the reasons for such persistence cannot be clearly made out; still less can they be foreseen. It has long been realized that the investigation of such problems demands a study of meteorology on a world-wide scale, and we may recall that the exceptional summer of 1911 provided the initial incentive which led to the regular publication of the collection of world weather statistics known by the name of the *Réseau Mondial*. If the harvest has not yet been garnered, we may, however, derive some satisfaction from the fact that there are many workers in the field, and also from the fact that some degree of success has rewarded the essays in 'seasonal foreshadowing' made in India and elsewhere.

Obituary Notices

Mr. J. E. Marsh, F.R.S.*

THE numerous friends and old students of James Ernest Marsh will have learned with regret of his death on April 13 at the age of seventy-seven years. He was one of the few remaining chemists whose most active period of work belongs to last century, having been University demonstrator in chemistry at Oxford from 1886. In my undergraduate days, 1896–98, Marsh in organic chemistry and V. H. Veley, who died at just the same age in 1933, in inorganic chemistry, were almost the only ones in Oxford keeping the flag flying as regards original work in the subject.

Marsh's influence on me started, indeed, at school, under R. E. Hughes, science master at Eastbourne College, who, whilst at Jesus College, had worked with Marsh, and was still being provided by him with materials and help in its continuation. Few schoolboys certainly can have prepared camphoryl chloride. But I still have a vivid recollection of carrying out this preparation on a large scale in the open playing field, adjoining the school laboratory, from camphoric acid and phosphorus pentachloride, and of the traditional 'torrents' of hydrochloric acid gas evolved. That, to a schoolboy, was the joyous beginning of a lifetime admiration.

At that time Marsh was deeply immersed in the study of camphor and the related group of terpenes. The problem of the constitution and synthesis of camphor was then very much to the fore, and some of the most eminent chemists, including the late Prof. W. H. Perkin, were engaged on it. In conjunction with his students, notably J. A. Gardner and A. Hartridge, Marsh published about twenty important papers in this field between 1889 and 1910, in the first of which he had suggested for camphor a highly original structural formula. Although this was ultimately disproved in favour of one propounded by Bredt in 1893, he made, in the course of the work, many interesting and important discoveries. The stereochemistry of this group led to great advances in our knowledge of that subject, and Marsh himself was the first to obtain, for the case of camphoric acid, *optically active* stereo-isomers of the *cis* and *trans* variety associated with the ring structure.

At this time Marsh was an acknowledged leading authority in the field of stereochemistry, and his lectures on the subject, drawing his illustrations and examples from this field, and many others such as the sugars, then undergoing intensive study, were most inspiring and threw an interesting light over the whole field of organic chemistry. Another topic on which he used to lecture regularly was the history of chemistry. In 1929 he collected in a book entitled "The Origins and the Growth of Chemical Science" his main conclusions, the chief of which was that the earlier work on salt formation and the fixation of gases by the British chemists, Boyle and Black, were the real beginning of the subject as a science rather than the later work of Lavoisier on combustion to which it is often ascribed.

In later years, largely with R. de J. F. Struthers, Marsh worked much on the numerous curious and interesting complexes formed by certain compounds

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of mercury with organic solvents and radicals, now ascribed, in the modern theory of valency, to the unique character of mercury among the metals and its power of forming covalent linkages of unusual type.

Another subject that attracted Marsh was the preservation of stone from decay, and in 1926 he wrote a highly original little monograph on the subject entitled "Stone Decay and its Preservation". Finding in decayed stone from diverse localities the presence of nitrates, he concluded that the decay was due to forms of life in the stone, such as the micro-organisms known to exist in it. The treatment to preserve it should aim at sterilizing it and keeping it sterile. The book concludes: "All that is recommended is to keep the walls of a building clean and thus prevent them from becoming nests of living organisms". In the last conversation I had with him, he discussed the chemistry of taste and was then working upon it.

Marsh was educated at Rugby and Balliol, studied also both in Germany and Paris, and for a short time was lecturer in materia medica in Oxford. He was made a fellow of the Royal Society in 1906, and served on the council of the Chemical Society in 1902–7. He was married in 1903 and leaves a widow and five daughters. In 1906, when forty-six years old, he astonished everyone by winning by examination an open prize fellowship at Merton College, which he held up to 1930, and during it filled for a time the office of sub-warden.

In his younger days Marsh was an intrepid yachtsman, and in company with one of the three Lynam brothers used to take long voyages in their small yacht among the Hebrides and even out into the open Atlantic. Inquiring for him in 1901 at Oban, knowing his intention of attending the British Association meeting at Glasgow that year, I found the local waterman in considerable anxiety, as nothing had been heard of the yacht or its crew for many weeks. He loved the Scotch crofters and liked to get right away among them and to share their mode of life. Though to unsympathetic people he may not have troubled much to make himself agreeable, he was essentially very human and lovable, and those who worked with him and were admitted to his friendship will cherish his memory with deep affection and loyalty. FREDERICK SODDY.

Captain R. S. Rattray, C.B.E.

WE record with deep regret the death of Captain R. S. Rattray, distinguished as an anthropologist and authority on the native peoples of West Africa, who was killed in an accident while gliding at Farmoor, near Oxford, on May 14, at the age of fifty-six years. Captain Rattray was acting as pilot of the Oxford University and City Gliding Club, which he himself had founded only a week before.

Robert Sutherland Rattray was son of the late Mr. A. Rattray of the Indian Civil Service, and grandson of the late Robert Haldane Rattray, Chief Justice of Bengal. He was educated at Stirling High School and Exeter College, Oxford, holding the diploma of his University in anthropology, and the degree of D.Sc. He was *Officier d'Académie* of France, and was called to the Bar by Gray's Inn in 1914. In the South African War he served as a trooper, receiving the Queen's medal with five clasps. In 1902 he entered the service of the African Lakes Corporation, British Central Africa, serving until 1907, when he entered the Colonial Civil Service on the Gold Coast. He became an assistant district commissioner in 1911, and thereafter held various administrative appointments, until in 1920 he was acting senior assistant Colonial Secretary and clerk to the Legislative Council. During the Great War he served in Togoland, being district political officer during the Anglo-French occupation in 1914–17. For his services he received the M.B.E. and was advanced to C.B.E. in 1929.

In 1924 Rattray was made head of the recently formed Anthropological Department in Ashanti. It is in connexion with Ashanti that Rattray's name will longest be remembered. He had already made some notable contributions to the study of the customs and folk-lore of West Africa, when soon after his appointment as Government anthropologist he published his "Ashanti" (1924). This was the first of a series of volumes, in which he made a comprehensive and detailed study of Ashanti social organization and law, art and religion. Much interest was aroused by his unravelling of the story of the Golden Stool of the rulers of Ashanti, which, long familiar to the British public, had been a mystery completely misunderstood, even by many whose position demanded more accurate information. This matter was certainly not without interest—great interest indeed—for the anthropologist, but the overwhelming value of Rattray's studies for his fellow workers lay in his accurate observation, his clear, precise statement, and his restrained, but illuminating, power of interpreting his facts in relation to their cultural environment. To a wider public, the volume containing his study of Ashanti art is made a standard work of reference by the inclusion of a contribution from Vernon Blake discussing the place of African art in relation to the principles of æsthetics.

One of Rattray's duties not long before his retirement was to make a survey of tribes of the hinterland brought under British control by mandate, but as little known to anthropological science as they were to the administration. This survey was made with a view to the introduction of some measure of indirect rule; and a record of the observations then made was published by him in his book "The Tribes of the Ashanti Hinterland" (1932). Its essential completeness, when considered in relation to the rapidity with which the work had to be carried through, is a lasting memorial of Rattray's quickness of observation and grasp of detail. On his retirement Rattray was a frequent lecturer on anthropological topics at Oxford and elsewhere; and it may be noted that he was then one of the first to point out that indirect rule is not a complete panacea for the difficulties of native rule, not the least of these,

(*Continued on page* 929.)

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SUPPLEMENT

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LETTERS TO THE EDITOR

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 928.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Physical Sciences

Reversibility of the Equations of Classical Dynamics

IN a recent series of papers, one of us has derived the equation of motion[1] of a free particle in the presence of the expanding universe by *a priori* methods, and constructed an associated dynamics. The observers' clocks were supposed so graduated[2] that the expansion appeared *uniform*, and the resulting scale of time was called the t-scale. But the equations of motion reduced to their classical form[3] only if observers' clocks were regraduated from t to τ where

$$\tau = t_0 \log (t/t_0) + t_0,$$

and all derived measures correspondingly changed. Accordingly, the 'uniform time' of mechanics was identified as τ-time. In this measure of time, the universe appears as a stationary, non-expanding system, and the red-shift is shown[4] to be attributable to an acceleration of atomic absorption- or emission-frequency with time in τ-measure, so that the light, emitted long ago by a distant nebula, appears relatively displaced to the red. In a joint paper about to appear in *Zeitschrift für Astrophysik*, we have analysed generally all monotonic graduations of our temporal experience, that is, all possible modes of clock-graduation, and shown that of these there is just one, τ-measure, which reduces the members of any 'linear equivalence' to relative rest. This again we have identified as the time of mechanics.

The object of the present communication is to point out that this identification can be at once confirmed from Mach's principle and the well-known fact of the reversibility of the classical mechanical equations—the fact that they are unaltered in form on replacing $d\tau$ by $-d\tau$. For, by Mach's principle, the equations of motion of a free particle express the relation of the particle-in-motion to the general distribution of matter and motion in the universe. Suppose we reverse the velocity of a free particle. Then it can only reverse its trajectory if the motion of all the other particles in the universe is reversed at the same time, and this will not actually occur unless these other particles are on the whole relatively *stationary*, when the reversal of *their* relative motion makes no difference. Accordingly, the equations of motion of a free particle may be expected to be unaltered in form on reversing the differential of time only when the scale of clock-graduation is so chosen that the fundamental particles appear as relatively stationary. Since the equations used in ordinary mechanics *are* unaltered in form by this transformation, it follows that the scale of clock-graduation they imply is the τ-scale, namely, that for which the universe is stationary, that is, non-expanding. In confirmation, it is at once found that the equations of motion in any other scale, in particular the well-discussed t-scale equation,

$$\frac{d\mathbf{V}}{dt} = -(\mathbf{P} - \mathbf{V}t)\frac{Y}{X},$$

are altered in form on reversing $\mathbf{V}$ and dt.

Since a red-shift is observed to exist, and since the universe is non-expanding in the ordinary mechanical or τ-scale, it follows at once that as regards the emission or absorption of radiation atoms cannot keep the τ-scale. Closer discussion has shown that the frequency of the photon emitted must be constant on the t-scale[5].

These considerations throw a flood of light on what used to be regarded as a grave difficulty: How can the secular increase of entropy be reconciled with the reversibility of the Hamiltonian equations? It now appears that the reversibility of the Hamiltonian equations is a peculiar property due to the particular choice of the scale of time in which the universe is relatively stationary. In general, for an arbitrary choice of clock-graduations, the dynamical equations are not reversible. Reversibility of equations of motion is therefore to be considered as irrelevant to

the onward march of entropy, which simply expresses the tendency towards a state of greater probability independent of the scale of clock-graduation adopted.

Eddington has directed attention[6] to three time-direction sign-posts: (1) our consciousness of the temporal sequence; (2) the expansion of the universe; (3) the increase of entropy. We now see that by suitable choice of clock-graduation the second is abolished and replaced by a statement about the acceleration of 'atomic clocks'. The first is basic and given, and is so used in our analysis. The third is not therefore 'the barb on time's arrow'—time's arrow is already barbed in the statement of the before-and-after relation in the observer's experience; the increase of entropy must therefore be a theorem, or consequence of the existence of the temporal sequence.

It is perhaps scarcely necessary to add that when in the above we use the term "relatively stationary", we are not appealing either to material measuring rods or to the indefinable 'rigid' length-measure. We mean simply that the light-time difference for a to-and-fro signal, measured on the appropriately graduated clock, is a constant.

E. A. Milne.

Wadham College, Oxford.

G. J. Whitrow.

Christ Church, Oxford.

April 28.

[1] Milne, E. A., *Proc. Roy. Soc.*, A, **156**, 69 (1936) and *Quart. J. Math. (Oxford)*, **8**, 22 (1937).

[2] Whitrow, G. J., *Quart. J. Math. (Oxford)*, **6**, 249 (1935).

[3] Milne, E. A., *Proc. Roy. Soc.*, A, **158**, 327 (1937). There are certain departures from the Einstein mechanics for speeds v approaching c.

[4] Milne, E. A., *Proc. Roy. Soc.*, A, **165**, 343 (1938).

[5] Whitrow, G. J., *Quart. J. Math. (Oxford)*, **7**, 271 (1936).

[6] Eddington, A. S., "Relativity Theory of Protons and Electrons" 225 (1936).

A New Boundary Condition and the Geodesic Postulate

Einstein and Rosen[1] have admitted that the geodesic postulate is an extraneous one and that the field-equations of gravitation must give both matter and motion independently of such a postulate. It has not been rigorously proved yet that the geodesic postulate is implicit in the field-equations[2]. A new boundary condition is stated here, couched in invariant terms; it is found to be satisfied by the Schwarzschild solution, and the content of the geodesic postulate that a test-particle describes a geodesic is shown to be implied by this condition. No extraneous postulate is necessary to account for the motion if the new boundary condition is accepted.

The inner and outer fields of an isolated spherical mass are given by the line-elements,

$$ds^2 = -\sec^2\chi dr^2 - r^2(d\theta^2 + \sin^2\theta d\varphi^2) + (A - B\cos\chi)^2 dt^2, \quad . \quad . \quad . \quad (1)$$

where $R\sin\chi = r$ and

$$ds^2 = -\left(1 - \frac{2m}{r} - \frac{\lambda r^2}{3}\right)^{-1} dr^2 - r^2(d\theta^2 + \sin^2\theta d\varphi^2) + \left(1 - \frac{2m}{r} - \frac{\lambda r^2}{3}\right) dt^2 \quad . \quad . \quad . \quad (2)$$

The boundary conditions that are satisfied at the common surface, $r = r_0$, are two, as usually stated: (i) the pressure $p = 0$ and (ii) $g_{\mu\nu} = g'_{\mu\nu}$, the dash indicating the external field. The boundary conditions in the corresponding problem of Newtonian gravitation suggest that there is one more condition satisfied by (1) and (2) at $r = r_0$; and that is found to be that the laws of mechanics, namely,

$$(T^r_\mu)_r = 0, \quad (3)$$

hold good whether we use the three-index symbols for $g_{\mu\nu}$ or for $g'_{\mu\nu}$ at the common surface. In other words, this boundary condition is $(T^r_\mu)_r = (T^r_\mu)'_r = 0$. In the one-body problem considered above, this merely demands $\Gamma^4_{r4} = \Gamma'^4_{r4}$ $(r = 1, 2, 3, 4)$, which condition is found to be satisfied at the boundary.

For a perfect fluid for which the condition of continuity holds good in the form $[(p+\rho)v^\delta]_\delta = 0$, if, at the boundary, the pressure-gradient is supposed to be negligible compared to the density, (3) reduce to the equations of geodesics[4],

$$(v^\mu)_\nu v^\nu = 0. \quad (4)$$

By the new boundary condition, (4) become geodesics not only of the inner but of the outer field also. Thus at the surface a fluid runs in geodesics of the external field. A particular case of this general result for a finite fluid mass is provided by a test-particle which, if treated as of negligible dimensions, traces a geodesic.

V. V. Narlikar.

Benares Hindu University.

April 2.

[1] Einstein and Rosen, *Phys. Rev.*, (ii), **48**, 1, 73.

[2] Becquerel, "Le Principe de Relativité", pp. 209–214 (1922). The proofs given here are not rigorous. Evidently they are not accepted by Einstein and Rosen.

[3] Tolman, R. C., "Relativity, Thermodynamics and Cosmology" 247 (1934).

[4] Narlikar, V. V., and Singh, Jaipat, *Phil. Mag.*, 629 (April 1937).

Distortion of Mountain Strata, Isostasy, and Glacial Periods

The connexion of the distorted mountain strata with isostasy has been examined in Nature of April 2, p. 603. The foundation of the argument was that the strata were originally deposited horizontally at the bottom of the sea. It is, however, necessary to go further back, for they must have been lifted to a great height before isostatic influences could begin to operate. There is here a problem of flow in a medium of extremely viscous type, namely, the outer region of the earth beneath, which can scarcely be avoided. If anywhere the horizontal drift beneath is from both sides towards the same centre the lighter material above it will be pushed up as is required, and in part also pushed down, but the resulting displacement need not at first be isostatically distributed. So also at ocean deeps the underlying drift away from the centre may carry along the more solid upper strata, thinning them out: anyhow a problem presents itself there. Moreover, in all internal motions the drift relative to the surface is necessarily tangential. The analogy of the sideway shrinking up of a flat roll of cloth has been employed.

The process here described would be remote in time. It can scarcely be going on now to any sensible degree, *unless isostatic conditions prevail*; for it would gradually alter the period of the earth's rotation, which is known for astronomical reasons to have been extremely steady for some thousands of years. This consideration also excludes any hypothesis of great accumulation of ice in the Arctic regions; for it would lower the general level of the oceans and a change of level of more than a few centimetres is not permitted. So too the land must have not altered its

mean level more than this in historic times. But in times beyond historical record this restriction does not apply. (These considerations favour the Darwin theory of the origin of coral reefs.)

This astronomical limit appears to be fundamental for geophysics. It asserts that change of level of the ocean of one centimetre is not permitted, unless the day was exceptionally longer in the glacial periods: if the water were removed to this depth and piled up uniformly on ice-caps within 5° or 350 miles of the poles, the resulting thickness would be only about 130 cm. or 50 inches, and if within 10° only 12 inches. Within such narrow limits are accumulations of ice now restricted. Sir George Simpson (NATURE, April 2) advances the view that recent ice ages may be due largely to change of temperatures of the Atlantic produced by drift of ice in it down into temperate latitudes; and here question arises as to the permanent source of supply of the ice. A different mode of origin which has found some favour with the writer is the temporary diversion of ocean currents on a large scale by ice piling up in the narrower parts of their channels and so blocking the flow. Both causes might operate. But the recent glacial period on the central Indian plains appears to be a more intractable proposition.

JOSEPH LARMOR.

Holywood,
Co. Down,
Northern Ireland.
April 12.

Maxwell's Equations and the "Flux-Cutting" Principle

IN NATURE of February 5, Dr. C. V. Drysdale attempts a simplification of Maxwell's electrodynamic equations, on the grounds that these in their original form are difficult to comprehend and to apply, and not completely fundamental. As regards the latter criticism, it must be admitted that Maxwell rarely leaves much scope for improvement in his mathematical statements of physical laws, and so far as the complexity is concerned, many years' lecturing experience have convinced me that the average electrical engineering student of pass degree standard finds little difficulty in understanding and appreciating the concise and elegant expression of the laws of induction, which he has had ample opportunity of testing experimentally in his laboratory work, and usually finds the wider applications, to transmission, skin effect, and metallic reflexion, both easy and interesting.

A closer examination of Dr. Drysdale's argument leaves my opinion of Maxwell's achievement unshaken.

The first modification is introduced rather abruptly with the words: "if we write $j\frac{\partial E}{\partial x}$ for curl E in the equation $-\text{curl } E = \dot{B}$ . . ." It is not easy to see any justification for this suggestion. It is true that the components of the vector curl E may be obtained by applying the differential operator $\mathbf{i}\frac{\partial}{\partial x} + \mathbf{j}\frac{\partial}{\partial y} + \mathbf{k}\frac{\partial}{\partial z}$ in a vectorial manner to the vector E, where $\mathbf{i}$, $\mathbf{j}$ and $\mathbf{k}$ are the unit vectors along the axes X, Y and Z, respectively, that is, by developing the determinant $\begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ E_x & E_y & E_z \end{vmatrix}$.

But here the scalar products $\mathbf{i}\times\mathbf{i} = \mathbf{j}\times\mathbf{j} = \mathbf{k}\times\mathbf{k} = 1$, and the vector products $\mathbf{i}\wedge\mathbf{i} = \mathbf{j}\wedge\mathbf{j} = \mathbf{k}\wedge\mathbf{k} = 0$, whereas Dr. Drysdale later asserts that $\mathbf{j}^2 = -1$, and thus confuses the unit vector $\mathbf{j}$ with the electrical engineer's phase rotating operator and tempts the reader to suspect that the relation $E = jVB$ expresses a quadrature phase difference between E and B.

The next step is equally sweeping and illegitimate: it consists in "writing" $\frac{\partial B}{\partial t} = \frac{\partial B}{\partial x}\frac{dx}{dt}$.

It is now obvious, however, that the original equations have been reduced by making some very special assumptions, namely, that $E_x = E_y = 0$, and $B_x = B_z = 0$, leaving

$$\frac{\partial E_z}{\partial x} = \mu\frac{\partial H_y}{\partial t} \text{ and } \frac{\partial H_y}{\partial x} = \epsilon\frac{\partial E_z}{\partial t},$$

and by this specialization a set of equations has been obtained which *ipso facto* is less general, that is, less completely fundamental, than the original system.

It is, of course, easy to obtain a simple wave equation from the above two equations, and the solution and discussion would seem fairly simple, but Dr. Drysdale prefers to introduce a magnet which is moved transversely through a non-conducting medium with a velocity V, inducing an E.M.F. $E = -j\mu VH$, this E.M.F. in turn inducing a magnetic force $H^1 = \epsilon\mu V^2 H$, etc. It is asserted that thus an electromagnetic wave is generated, though it is not easy to trace any connexion with wave motion in the ordinary sense. It is further pointed out that, as the velocity increases, the fields will increase, unless H is diminished to $H - H^1 = (1 - \epsilon\mu V^2)H$, and it is concluded that when $1 - \epsilon\mu V^2 = 0$, H is also 0. This is tantamount to a statement, that when one factor in a product is 0, the other factor is also 0.

The extension of this argument to the case of semiconductors shows an equal disregard for elementary rules of ordinary, partial and total differentiation and leads to yet another curious equation,

$$\frac{d^2E^1}{dt^2} = V^2\frac{\partial^2 E^1}{\partial t^2}.$$

Dr. Drysdale's main contention is that flux-cutting is more fundamentally correct, as an E.M.F. inducing agent, than flux variation, but it is well to remember that when the dynamo designer speaks of a conductor, he is at the moment concentrating his attention on one side only of a complete armature coil—if the other side were not there, his dynamo would scarcely be a success. It is, of course, the flux variation through the armature *coil* which generates the E.M.F. Dr. Drysdale himself admits that, in the case of a transformer, the flux variation principle is correct (and even "more convenient"), and the attempt at saving the flux-cutting principle, by invoking some mysterious and incomprehensible "cutting" by a stationary coil, can scarcely be taken seriously.

Yet Dr. Drysdale claims to have rendered Maxwell's equations more completely fundamental and more intelligible, and urges that his representation "should be adopted". It might well be asked—by whom? If text-book writers were to adopt this kind of argument, it could only add to the confusion.

J. A. WILCKEN.

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London, W.1.

No one has a greater admiration for Maxwell's magnificent achievements than I have, and so far from wishing to decry them, my main object has

been to help to restore them to their rightful place as the greatest scientific generalization we have seen. But there has been a decided tendency to neglect them of late, and I am convinced that this has been due to the complexity of the mathematical processes associated with Maxwell's equations, which has obscured their simple physical basis and conclusions. Dr. Wilcken is to be congratulated on being able to make them easily intelligible to students, but quite recently a professor of physics at a leading London college told me frankly that he had never been able to understand Maxwell's electromagnetic theory of light, and I have found that considerable confusion exists among all with whom I have discussed it. The simplified treatment has given me a much clearer realization of the physical processes involved and has convinced me that Maxwell's conclusions were entirely sound although his equations were not completely fundamental.

Dr. Wilcken commences by objecting to my "abrupt" substitution of $j\frac{\delta}{\delta x}$ for Maxwell's curl function, and suggests that it was introduced as a quasimathematical device to give colour to a preconceived bias in favour of the flux-cutting principle. I admit and am sorry for the abruptness, but my article was a highly condensed epitome of a long unpublished paper and was intended merely to give an outline of the theory in the shortest possible space. According to my recollection and notes, the inspiration for the modified (apparently I must not say "simplified") equations arose from wrestling with the array of differential equations in Drude's "Theory of Optics"; and becoming tired of the effort I decided on examining the problem of electromagnetic wave propagation from first principles. The most simple way of doing so was to consider a forced electromagnetic disturbance created by moving a magnet with wedge-shaped gap with velocity V in a direction transverse to its magnetic field B and in a plane containing the normals to its plane faces; and it was easy to see that in this case curl $E = \frac{\delta E}{\delta x}$ as regards magnitude and that $\dot{B}\left(=\frac{dB}{dt} = \frac{\delta B}{\delta t} + \frac{\delta B}{\delta x}\frac{dx}{dt} + \frac{\delta B}{\delta y}\frac{dy}{dt} + \frac{\delta B}{\delta z}\frac{dz}{dt}\right) = \frac{\delta B}{\delta x}\frac{dx}{dt} = V\frac{\delta B}{\delta x}$; so that Maxwell's third equation-curl $E = \dot{B}$, becomes $-\frac{\delta E}{\delta x} = V\frac{\delta B}{\delta x}$, or $E = -VB$, if $E = 0$ when $V = 0$. Similar treatment of Maxwell's fourth equation, curl $H = 4\pi\dot{D}$, of course gave $\frac{\delta H}{\delta x} = 4\pi V\frac{\delta D}{\delta x}$, or $H = 4\pi VD = VJ$ if $H = 0$ when $D = 0$, and $J = 4\pi D$. As x disappears in the integration, the equations $E = -VB$ and $H = VJ$ are independent of the direction of propagation.

Up to this point, I had not considered the flux-cutting principle, but the correspondence of the equation $E = -VB$ with the dynamo designer's or flux-cutting formula of course struck me, and as I had long ago come to the conclusion that Faraday's rotating disk experiment showed that the induced E.M.F. was due to the cutting of the magnetic flux, it was apparent immediately that the equation $E = -VB$ was not a mere transformation of Maxwell's third equation but an expression of an independent experimental fact. Similarly Rowland's demonstration that a magnetic field was induced by the rotation of two oppositely charged disks or the cutting of an electrostatic field afforded experimental verification of the formula $H = VJ$. The two equations $E = -VB$ and $H = VJ$ may therefore be regarded simply as direct expressions of the results of Faraday's and Rowland's rotating disk experiments, and my original derivation of them by transformation of the Maxwellian equations, which I quite admit was not general, is of no importance except as showing a connexion between them. The equations $E = -[VB]$ and $H = [VJ]$ are completely general, and I hope to show that they are more fundamental.

As Dr. Wilcken does not like my employment of the quadrantal versor $\mathbf{j} = \sqrt{-1}$ to indicate the directions of the induced forces, on the grounds that it leads to confusion with its use in alternating current theory and with vector analysis, there is no objection to writing the four equations for an isotropic dielectric as $J = \varepsilon\dot{E}$, $B = \mu H$, $E = VB$, and $H = VJ$, and leaving the directions to be determined by the ordinary rules. I fail to see, however, why students who are familiar with the use of $\mathbf{j}$ for alternating current vectors should be confused by its application to any other vectors.

I dissent entirely from Dr. Wilcken's remarks concerning the flux-cutting principle, but to deal with them and his complete misapprehension of my method of explaining the generation and propagation of an electromagnetic wave would take too much space for a note; and I propose shortly to submit a further article, which I hope will make the flux-cutting principle and its application quite clear and indisputable.

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Why do we have Winter Heating?

THE layman will answer: "To make the room warmer." The student of thermodynamics will perhaps so express it: "To import the lacking (inner, thermal) energy." If so, then the layman's answer is right, the scientist's wrong.

We suppose, to correspond to the actual state of affairs, that the pressure of the air in a room always equals that of the external air. In the usual notation, the (inner, thermal) energy is, per unit mass,

$$u = c_v T.$$

(An additive constant may be neglected.) Then the energy content is, per unit of volume,

$$u' = c_v \rho T,$$

or, taking into account the equation of state,

$$p/\rho = RT,$$

we have

$$u' = c_v p/R.$$

For air at atmospheric pressure,

$$u' = 0{\cdot}0604 \text{ cal. cm}^{-3} = 60{\cdot}4 \text{ Cal. m.}^3$$

The energy content of the room is thus independent of the temperature, solely determined by the state of the barometer. The whole of the energy imported by the heating escapes through the pores of the walls of the room to the outside air.

I fetch a bottle of claret from the cold cellar and put it to be tempered in the warm room. It becomes warmer, but the increased energy content is not borrowed from the air of the room but is brought in from outside.

Then why do we have heating? For the same reason that life on the earth needs the radiation of the sun. But this does not exist on the incident energy, for the latter apart from a negligible amount is re-radiated, just as a man, in spite of continual absorption of nourishment, maintains a constant body-weight. Our conditions of existence require a determinate degree of temperature, and for the maintenance of this there is needed not addition of energy but addition of entropy.

As a student, I read with advantage a small book by F. Wald entitled "The Mistress of the World and her Shadow". These meant energy and entropy. In the course of advancing knowledge the two seem to me to have exchanged places. In the huge manufactory of natural processes, the principle of entropy occupies the position of manager, for it dictates the manner and method of the whole business, whilst the principle of energy merely does the book-keeping, balancing credits and debits.

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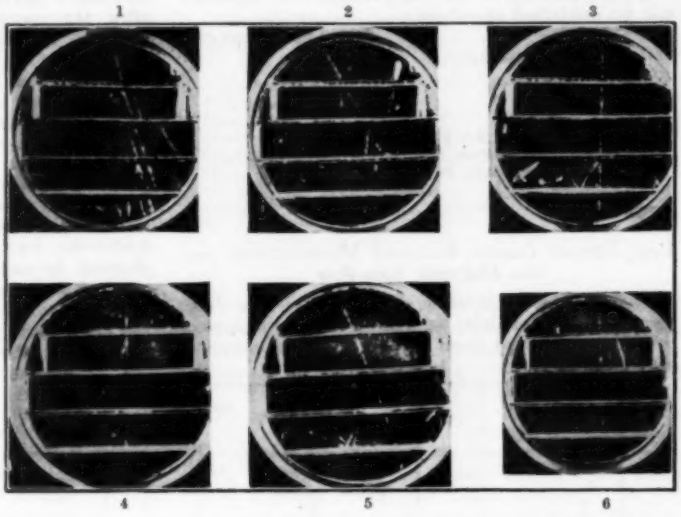
Secondary Effects of the Hard and Soft Components of Cosmic Rays

It has been shown in a previous paper[1] that the major part of the electron showers produced in a lead plate are formed by a 'cascade process' in accordance with the shower theory proposed by Bhabha and Heitler[2] and Carlson and Oppenheimer[3]. Our experiments have been made with an automatic cloud chamber. Four lead plates of 3 cm. thickness are placed inside the chamber in a distance of 5 cm. A cloud chamber divided up in this way offers good opportunity of studying the way in which the showers are generally produced.

Fig. 1 shows a typical 'cascade process'. In later experiments two counters were used to detect the passage of the particles through the cloud chamber. One was placed above and the other below the chamber in such a position that any ray passing straight through both must also go through the chamber and the four lead plates. The intention was to study the production of secondaries when the primaries pass the lead plates and to make statistical investigations of their frequency in the various sections. Figs. 2 and 3 show some track photographs made in this way. Secondary, not ionizing, light quanta are here seen to have produced ionizing particles near the main ray.

A statistical examination of results, obtained without screening the chamber, gives the following result. Out of every 100 particles (hard plus soft radiation) passing the chamber, 30 were without visible secondary effect. 26 tracks were found in section I, 35 in II, 44 in III, and 45 in IV, the sections being numbered from above. The cloud chamber was then screened with an iron filter of 33 cm. in order to absorb the soft radiation. In this way it was possible to ascertain whether the hard radiation gave the same statistical results as the hard plus soft radiation. The following result was obtained: Out of every 100 particles of the hard radiation, 41 give no visible effect. 18 tracks were found in section I, 21 in II, 22 in III and 23 in IV. Thus the hard radiation gives considerably less secondaries than the hard



plus soft radiation. Assuming now that the 30 particles without visible secondary effect in the first experiment all belong to the hard component, we shall find, in agreement with experiments, that the soft component amounts to about 27 per cent of the total radiation at the earth's surface.

In order by these calculations to get a correct value of this distribution factor, we are furthermore forced to assume that the quantities of hard particles being transformed into soft particles in the filter are negligible. On this assumption, we can now calculate the statistical distribution of secondaries for soft rays alone. We will find that practically all the soft rays give visible secondary effects, and as distinct from the hard rays the number of secondaries increases rapidly from one section to the other in the downwards direction. The number of secondaries stated in this way seems to be in good agreement with the electron absorption theory of Bhabha and Heitler.

The theory has been proposed that the hard rays are electrons having an energy higher than some critical energy above which the quantum absorption theory is not valid. If this be correct, we shall have to assume that the iron filter will decrease the energy of some of the hard particles and in this way produce a new soft radiation component. Our experiments seem, however, to show that this cannot be the case, and consequently we shall have to conclude that the hard particles cannot be electrons.

As to the secondary effect of the hard rays, it might be mentioned that the secondaries most frequently form a branch of the main rays, as shown in Fig. 4. Secondaries—electron pairs and single rays—among which are found strongly ionizing nuclear particles, may, however, also appear at some distance from the main ray according to the effects shown in Figs. 5 and 6. Such cases show that the hard radiation also may be accompanied occasionally

by hard light quanta, which are thus able to produce cascade processes. The processes producing these secondaries may be of various kinds, such as nuclear reactions and head-on collisions with subsequent production of light quanta and pairs of the fast secondaries.

A fuller account of these and further investigations will be published elsewhere.

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April 9.

[1] Trumpy, B., *Det. Kgl. N.V.S. Forh.*, **10**, nr. 37 (1937).
[2] Bhabha and Heitler, *Proc. Roy. Soc.*, **A, 159**, 432 (1937).
[3] Carlson and Oppenheimer, *Phys. Rev.*, **51**, 220 (1937).

High-Altitude Cosmic Radiation Measurements near the Magnetic Axis-Pole

THE Wordie Expedition of 1937 to Baffin Bay[1] gave us an opportunity of making measurements of cosmic radiation at great heights in the atmosphere near the magnetic axis-pole. Free balloons were used, the method employed being that of Prof. E. Regener, to whom we are very much indebted for invaluable help. Our two most successful flights were made within 5° of the pole, one with an ionization chamber and one with a triple counter set giving coincidences for vertical rays. The result of the ionization chamber flight is shown in Fig. 1 and that of the counter flight in Fig. 2.

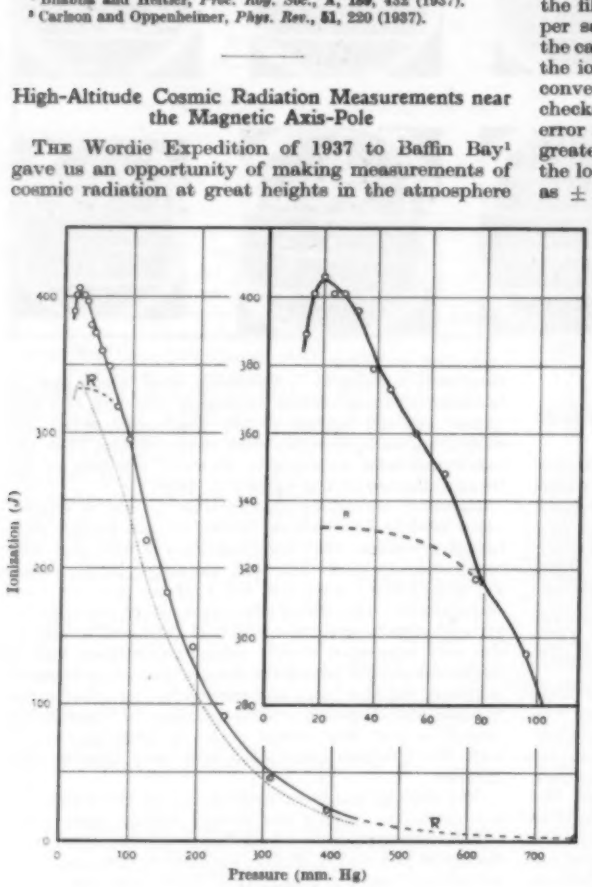

Fig. 1

IONIZATION CHAMBER MEASUREMENTS. ..... ACTUAL RESULT λ 85°; – – – – – REGENER, λ 49°; ——— λ 85° CURVE INCREASED BY 20 PER CENT.

The ionization chamber was a steel sphere of wall thickness 0·5 mm. and collecting volume 3 litres. It was filled with argon at a pressure of about 6 atmospheres, and the collecting field was everywhere greater than 30 volts per cm. The electroscope was similar in construction to that of Neher[2], but in addition it was made to recharge itself automatically, after the manner of the ticking electroscope of Zeleny. The rate of leak of the electroscope was recorded, along with the pressure of the air and the temperature of the apparatus, on a moving photographic film. Relative values of the cosmic ray ionization are proportional to the rate of leak of the electroscope system and were found directly from the film record. Absolute values in ion pairs per c.c. per sec. in normal air were obtained by measuring the capacity of the electroscope system and converting the ionization in argon so found to that in air. The conversion factor 0·72 was used[3], after it had been checked by experiment with γ-rays. The probable error of the absolute magnitude of the ionization is greater than that of the relative values, except in the lower parts of the atmosphere, and may be taken as ± 5 per cent. The probable error of the pressure measurements is ± 1 mm. mercury, the lowest pressure reached being 12·5 mm. mercury.

The coincidence counter apparatus consisted of three Geiger-Müller alcohol-filled tubes[4] coupled through a conventional Rossi circuit to an 8-metre oscillator designed for the purpose by J. A. Ratcliffe. In order to actuate all three counters, a particle must traverse 0·3 mm. of brass and 4·25 mm. of pyrex. Each particle vertically directed within a cone of semi-angle 20° gave rise to a radio pulse which was received at ground-level by a commercial superheterodyne receiver, and the impulses were counted on a three-stage scale of a two vacuum tube counter. The air pressure was recorded by variation of the wave-length of transmission. This was checked by direct measurement of the height of the apparatus by means of theodolites, and in one flight, when the apparatus was recovered, by a recording meteorograph. The most valuable counter observations were made on this flight at magnetic latitude λ 88°.

The curve *R* in Fig. 1 is that of Regener[5] for λ 49°. It is to be expected that in the lower atmospheric levels the ionization curve near the pole should be identical with that of Regener, and when our curve is increased by 20 per cent, good agreement with Regener is in fact obtained for pressures above 90 mm. mercury. Our experimental points are shown on this adjusted curve. Similar agreement with Millikan and Neher[4] in λ 52° for pressures above 50 mm. (that is, for the whole range of their curve) can be obtained by increasing our results by 60 per cent. It is reasonable to conclude that these differences of absolute value are due chiefly to differences of the wall effect of the ionization chambers used.

The curve obtained near the magnetic pole, if the adjustment of the absolute results is valid, shows larger ionization near the top of the atmosphere than Regener's curve at λ 49°, and at 20 mm. mercury shows a well-defined maximum. It is not possible to

say whether the radiation producing this increase reaches the earth at about λ 50° or nearer the pole. The available measurements of Millikan and Neher at λ 52° do not extend quite high enough to decide this point. We hope, however, soon to have flights in Great Britain with the same apparatus.

The coincidence counter results in Fig. 2 are compared with those of Pfotzer[7] taken at λ 49°. The curves are fitted at ground-level and are seen to agree closely at low pressures. At intermediate pressures Pfotzer's curve lies below ours. It should be noted, however, that Johnson[8] at approximately the same latitude as Pfotzer finds a similar deviation. If real, its origin is not clear.

The general conclusion reached by both types of measurement is that the radiation intensity at the pole is approximately equal to that at λ 50°. This is in agreement with the indications given by the results of Cosyns[9] between λ 47° and λ 51°. It is probable, consequently, that the radiation intensity at high altitudes, which increases markedly from the equator to λ 50°, remains thereafter constant to the pole. These experiments indicate, therefore, that cosmic rays of energy less than about 3×10^9 e.-volts either do not exist in space or are prevented from

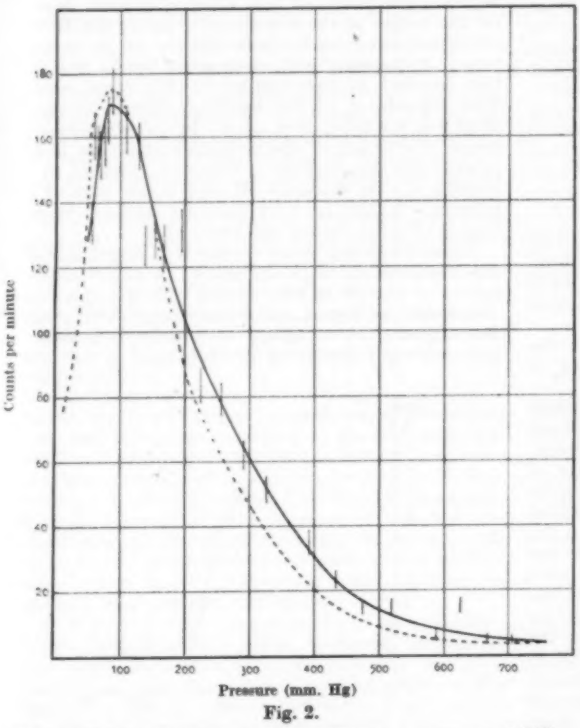

Fig. 2.

COINCIDENCE COUNTER MEASUREMENTS. ——— λ 88°; – – – – PFOTZER, λ 49°.

reaching the earth by an agency other than the terrestrial magnetic field. Janossy[10], on the basis of Cosyns's results, has shown that a solar magnetic field of reasonable magnitude will cut off rays of energy less than 3×10^9 e.-volts.

We are deeply indebted to Mr. Wordie for providing the opportunity for this work, to all the members of the expedition and of the ship's crew for their help with the flights, and especially to Mr. I. M. Hunter for his work with the radio technique.

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April 11.

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[2] *Phys. Rev.*, **50**, 15 (1936).
[3] COX, *Phys. Rev.*, **45**, 503 (1934).
[4] Trost, *Z. Phys.*, **105**, 399 (1937).
[5] *Naturwiss.*, **25**, 1 (1937).
[6] *Phys. Rev.*, **46**, 641 (1934).
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[9] *Z. Phys.*, 104, 430 (1937).
[10] NATURE, **137**, 616 (1935).

Transfer of Helium II on Glass

KAMERLINGH ONNES[1] observed in 1922 that the surfaces of two volumes of liquid helium II, that is, helium below the λ point, in two concentric vessels adjusted themselves automatically to the same level. No further observations of this strange 'distillation' phenomenon appear to have been made in Leyden or elsewhere. Rollin[2], however, found that the loss from vessels containing liquid helium II is exceptionally high, and he attributed this to some effect connected with the formation of a thin layer of helium II on the inner walls of the connecting tube. This, he suggested, might be connected with the above-mentioned phenomenon. We have lately carried out experiments with various arrangements of vessels in order to reproduce the effect observed by Kamerlingh Onnes and to investigate it systematically.

In one very convenient apparatus we utilized a small glass beaker suspended on a thin glass fibre which could be lowered into a bath of liquid helium II or raised out of it. The heat influx was reduced to a minimum, 0·5 c.c. of liquid at 1·5° K. evaporating per hour. As it was found that light from an ordinary incandescent filament lamp was absorbed (probably on the glass wall) and disturbed the effect, our observations were carried out with a neon lamp. The following phenomena were observed:

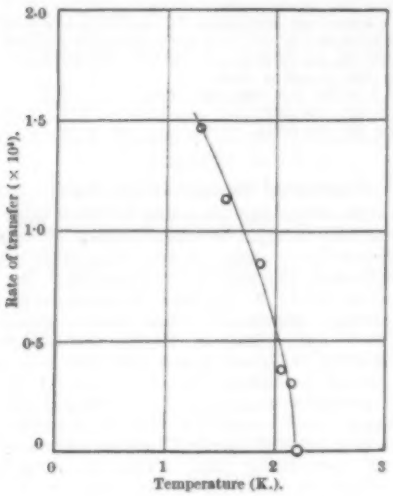
(*a*) When the empty beaker was lowered into the liquid, it filled up to the level of the bath although the rim of the beaker was everywhere above the level of the liquid.

(*b*) When the beaker was partly lifted out of the bath, the level of the liquid in the beaker fell at the same rate as it rose in (*a*), and the level of the bath rose until both had reached the same height.

(*c*) In order to establish whether the transfer took place by distillation through the gas phase or by transfer over the surface, the effect was examined of introducing 'wicks' of twisted copper wire which increased the surface leading from one level to the other. It was found that this increased the rate of transfer to several times the previous rate so long as, but only so long as, the wick reached into the liquid at the higher level.

(*d*) When the beaker (without a wick) was lifted completely out of the bath, it was found that the liquid vanished at the same rate as when it was still partly dipping into it. This was accounted for when it was observed that the liquid collected in drops at the bottom of the beaker and dripped into the bath.

(*e*) The rate of transfer did not appear to differ very greatly whether the beaker was almost full or nearly empty, the rate decreasing only by 20 per cent when the level had dropped from within 0·5 mm. of the rim to some 20 mm. from the rim.



(*f*) As shown in the accompanying figure, the rate of transfer increased rapidly with decreasing temperature. The rate is given in cubic centimetres of liquid per second per centimetre of glass surface cutting the surface of the liquid.

(*g*) If any of these phenomena occur above the λ point, the rate is so slow that they could not be observed in our experiments.

These experiments appear to show that the surface of a solid in contact with liquid helium II is covered with a helium film through which the liquid is transferred to the lowest available level. The rate of transfer on glass (it was found to be much higher on copper) appears to be of the order which one would expect if a monatomic layer were to move with the average kinetic velocity of the molecules. But the fact that the rate of transfer increases rapidly with falling temperature seems to indicate that the phenomenon depends not so much on the molecular velocity as on the viscosity, which decreases[3] as the temperature falls. Whether this is to be attributed to the obvious explanation that the de Broglie wavelength increases with falling temperature is a question which must be left until further experiments have enabled a more complete theory of the two phases of the liquid state of helium to be evolved.

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April 16.

[1] Kamerlingh Onnes, H., *Comm. Leiden*, 159.
[2] Rollin, B. V., Actes 7. Cong. int. du Froid, 1, 187; Prof. Simon informs us that a full account will be published shortly.
[3] Allen, J. F., and Misener, A. D., NATURE, **141**, 75 (1938.)

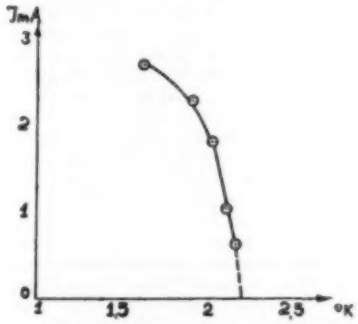
Experiments with Liquid Helium II

N. Kürti, B. V. Rollin and F. Simon[1] found that below the λ-point liquid helium slips over the surface of the tube lowered into it. They observed this phenomenon by increasing the flow of heat along the tube. We have made a more detailed investigation in order to obtain some quantitative characteristics of this phenomenon. We used the following method.

A glass tube 4 mm. in diameter, insulated by a vacuum vessel, is immersed in liquid helium with only its lower part surrounded by the liquid; and the remainder is allowed to project above the level of the liquid helium bath. On the upper parts of the glass tube a copper tube is soldered, on to which a heating coil of constantin wire (0·1 mm.) and a resistance thermometer of phosphorbronze wire (0·1 mm.) are wound.

When the lower part of the tube is surrounded by liquid helium II, its upper part has the same temperature as the lower part, that is, the temperature of the liquid helium in the Dewar vessel. When heat was introduced electrically by means of the heating coil, almost no heating is observed (the temperature gradient in this case is approximately 2×10^{-4}° K.). At a fixed value of the current, intensive heating begins. The value of this limiting current depends on the height of the thermometer above the level of the liquid helium in the bath and also on its temperature; it increases with decreasing height and with the decrease in temperature of the liquid helium. The dependence of the limiting currents upon the height is, however, very weak. In the accompanying graph, the values of the limiting current are plotted against the temperature. When the current in the heating coil is switched off, the upper part of the tube very rapidly (in a few seconds) acquires the same temperature as that of the lower part.

When the Dewar vessel is filled with liquid helium I, this phenomenon does not occur; with the smallest values of current in the heating coil, the upper part of the tube is warmed, and on switching off the current the temperature equalizes very slowly (because of the heat conductivity of the tube and of the wire).



It appears that over the surface of the tube a fine film of liquid helium II is formed, which, owing to its abnormally high heat conductivity, equalizes the temperature of the upper and lower parts of the tube, even although the height of the thermometer above the level of the liquid is comparatively great (about 150 mm.). This film at the limiting value of the current evaporates, and only then does the heating begin. The phenomenon takes place even with a metallic tube.

From the values of the limiting current and that of the heat of evaporation of liquid helium, it is possible to estimate very roughly the thickness of the film. It appears to be of the order 10^{-5} cm. We obtained the same value when we determined the thickness from the value of the temperature gradient along the film, if we assume the heat conductivity of liquid helium to be 10^4 cal./gm.cm.sec., as found by Allen, Peierls and Zaki Uddin[2]; in their experiment the temperature gradient was of the same order as ours.

Kapitza recently supposed that the abnormally high thermoconductivity of helium II can be explained by the presence of strong convection currents in helium; it is evident, however, that with such extremely thin films as in our case (10^{-5} cm.) such convection currents could scarcely be formed.

At present, experiments on the direct determination of the film thickness are in preparation, and a detailed description of them will shortly be published.

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B. G. LASAREW.

Ukrainian Physico-technical Institute,
Kharkov. April 20.

[1] Kürti, N., v. Rollin, B., and Simon, F., *Physica*, **3**, 266 (1936).
[2] Allen, J. F., Peierls, R., and Uddin, M. Z., NATURE, **140**, 62 (1937).
[3] Kapitza, P., NATURE, **141**, 74 (1938).

Transport Phenomena in Helium II

F. LONDON[1] has recently proposed a new conception of helium II, according to which this liquid can be regarded as a degenerate Bose-Einstein gas, that is, as a system in which one fraction of the substance—say, n atoms per cm.^{3}—is distributed over the excited states in a way determined by the temperature, while the rest—$n_0 - n$ atoms per cm.^{3}—is 'condensed' in the lowest energy level. If T_0 denotes the temperature of degeneracy, the ratio n/n_0 is given by

$$n/n_0 = (T/T_0)^s \text{ for } T < T_0 \qquad (1)$$

For an ideal Bose-Einstein gas, according to London, $s = 3/2$, but for the real fluid one should rather insert $s = 5$ in order to fit Keesom's specific heat measurements.

The calculation of viscosity of a degenerate Bose-Einstein gas is in progress. A preliminary estimation shows that the atoms belonging to the lowest energy state do not take part in the dissipation of momentum. Thus, the viscosity of the system is entirely due to the atoms in excited states. This simple description allows us to account in a qualitative way for the well-known transport phenomena in helium II, though in the more exact treatment certain modifications have to be introduced, which are to be discussed in a detailed publication.

(1) Measurements of the damping of an oscillating cylinder will show the effect of atoms in excited states only. To a first approximation the viscosity, measured in this way, should be the same as the viscosity of helium gas at the same temperature. The value of the viscosity coefficient of helium gas at $T \sim T_0$ is $\mu \sim 10^{-6}$ c.g.s. units[4], while measurements in helium II just below the λ-point[2] give $\mu = 3 \times 10^{-6}$. Parallel measurements of the viscosity of helium II and helium gas in the corresponding range of temperature would provide us with an indication as to what extent the simple picture adopted here has to be refined.

(2) It is, however, not the viscosity coefficient μ which determines the flow velocity of helium II moving under the influence of a pressure gradient through a capillary. In this case, the fraction of substance consisting of atoms in the lowest energy state will perform—like a 'superfluid' liquid of viscosity $\mu \sim 0$—some sort of turbulent motion the flow velocity of which does not depend on the bore of the capillary. In addition, the atoms in excited states, behaving like a gas of pressure $\sim nkT$, will diffuse in a similar way to, say, molecules in a solution under the influence of a gradient of osmotic pressure. Thus, the total flow represents a rather complex combination of both these effects. It will largely depend on the ratio $(n_0 - n)/n$ and, therefore, on T, in agreement with experiment[3]. According to this interpretation, a temperature gradient should arise during the flow of helium II through a thin capillary.

(3) The so-called fountain phenomenon[4] of helium II is an inverse process to (2). If one maintains a temperature difference between the ends of a capillary, a gradient of density of excited atoms, n, and, thus, of pressure is produced. In consequence, (a) the excited atoms will diffuse towards the colder end, and (b) the super-fluid fraction of the liquid moves in the opposite direction. In the case of a wide tube, these currents must be equal and no resulting flow will be observed. If, however, the capillary is sufficiently narrow, the rate of the process (a) becomes reduced and the temperature gradient causes a surplus convection current opposite to heat flow. This picture can account for the great values of the heating current required to maintain a temperature difference at the ends of the capillary[5]. Simultaneous measurements of the heating current and the total convection of substance could provide us with information about the relative magnitude of the processes (a) and (b).

A detailed discussion of the problem will be given in the *Journal de Physique*. I am greatly indebted to Dr. F. London for the opportunity of seeing his paper before publication.

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Paris. April 16.

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A Simple Inexpensive Ultracentrifuge

IN designing quantitative ultracentrifuges costing only a few pounds and available for measurements of sedimentation velocity and of sedimentation equilibrium, it is clearly best to adopt the simple modification of the air-driven spinning top of Henriot and Hugenard, in which the essential part of the system is immobilized by mechanical baffles[1]. This dispenses entirely with an optical system and depends upon direct analysis of the liquid after ultracentrifuging, using any suitable chemical, physical or biological method. Such opaque ultracentrifuges possess the further advantage over any transparent ultracentrifuge that the whole of the column of liquid from its upper surface outwards and from the very beginning of the sedimentation is available, without distortion, for exact measurement.

Cells which are ideally radial are made either from circular disks or from circular annular washers. Spacing pieces which leave the cell completely unobstructed are made from disks or washers of less width. The liquid, which may be aqueous or non-aqueous, is rendered so completely convectionless that the rotor may be stopped and dismantled for analysis without appreciable disturbance. The disks or washers may be made of any solid material that holds its form under the experimental conditions. We have found suitable such as can be cut from sheets of coin silver (10 per cent copper) a few thousandths of an inch in thickness.

Washers are suitable immobilizers for sedimentation equilibrium in any system, as described by McBain and Tostado in the accurate determination of the sedimentation equilibrium of sucrose[1]. Since then, Tiselius, Pedersen and Svedberg[2] have communicated an analytical method applied to the contents of their ultracentrifuge, giving their formula for calculating sedimentation velocity.

We now communicate measurements of sedimentation velocity of egg albumin with the disk method[4] in a 37 mm. rotor driven at 120,000 r.p.m. by air of 60 lb. pressure per sq. in. Each of fifteen attempts has been successful. In the last five the ultracentrifuge was held at constant known temperature to within 0·1° C. by the simple device of passing the driving air through a copper coil in a thermostat. Any desired temperature may be selected and held constant to within 0·01° C.

It is obvious that the same result should be arrived at whether the amount of protein leaving the immobilized liquid or arriving in the outer liquid is determined. About 2·2 c.c. of liquid is employed.

The results are expressed as sedimentation velocity in water at 20°. Analysis of the outer liquid gave $s_{20} = 3{\cdot}68,\ 3{\cdot}69,\ 3{\cdot}40,\ 3{\cdot}59,$ and $3{\cdot}64 \times 10^{-13}$, respectively; mean $3{\cdot}60 \times 10^{-13}$. Analysis of the inner liquid gave $s_{20} = 3{\cdot}35, 3{\cdot}61, 3{\cdot}42, 3{\cdot}89 \times 10^{-13}$, respectively; mean $3{\cdot}57 \times 10^{-13}$. Svedberg's most recent result[5] is $3{\cdot}55 \times 10^{-13}$.

Similar results have been obtained with the same material by A. H. Lewis using an improved form of the McBain-O'Sullivan transparent ultracentrifuge[1]. Incidentally, these observations show that there is no wall effect upon velocity of sedimentation or diffusion where the spaces are as small as 0·01 mm., as would indeed be expected from hydrodynamic theory. The protein particles or molecules are 20,000 times smaller than the capillary spaces.

Polydisperse systems require that runs be made at several speeds for different times. There is also the advantage that analysis for every constituent may be carried out independently.

Complete details are being communicated elsewhere; the simple equipment was shown at the National Colloid Symposium, Cambridge, Massachusetts, on June 9–11 last year.

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April 11.

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Properties of Variable-Width Sound Film as an Optical Diffraction Grating

IN a recent letter in NATURE[1], D. Brown described an ingenious and simple method of obtaining acoustic spectra, namely, by using a strip of 'variable-density' sound film as a diffraction grating for light. If the transparency of the film is modulated by one frequency only, the spectrum obtained will only contain the orders zero and plus and minus one. Higher orders do not occur. If the transparency is modulated by a complicated sound, the place and intensity of the different lines in the spectrum will give immediate visual information on the spectral composition of this sound.

It may be interesting to describe shortly the behaviour of 'variable-width' sound film as an optical diffraction grating.

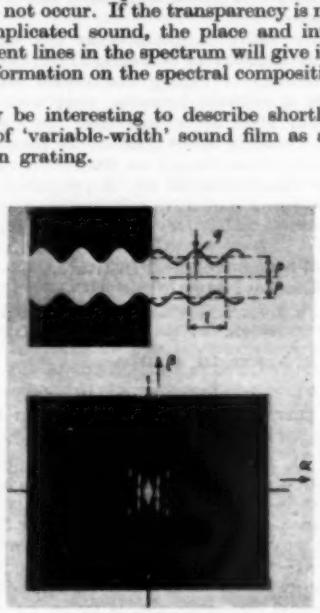

FIG. 1.

The diffraction pattern of a single frequency obtained with a point source of monochromatic light ($\lambda = 5461$ A.) is shown in Fig. 1. The point of symmetry corresponds with the direct image of the light source, the vertical line through it with the order zero, the first vertical line on each side with the order one. It is clearly seen that now higher orders are also present. Visually as many as twenty orders could easily be perceived.

The intensity of the light along a vertical line of order n, apart from an immaterial constant, is given by:

$$\frac{1}{\beta^2} \cdot \sin^2\left(\frac{2\pi\beta p}{\lambda} + \frac{n\pi}{2}\right) \cdot J_n^2\left(\frac{2\pi\beta q}{\lambda}\right) \quad . \quad . \quad . \quad (1);$$

where $2p$ is width of zero track; q is maximum amplitude of modulation on both sides; l is length of period; λ is wave-length of the light; J_n is a Bessel function of order n; β is angle of diffraction in vertical direction; $\alpha = n\lambda/l =$ angle of diffraction in horizontal direction.

It can be easily derived from (1) that the intensity along the α-axis ($\beta = 0$) is identical with the intensity obtained with variable-density film, if the same percentage modulation is used. Thus all orders higher than one vanish, as can be seen in Fig. 1.

The intensity along a line of order n is mainly given by a Bessel function of that order. A Bessel function of order n remains practically zero for low

values of the argument and reaches its first maximum for a value of the argument equal to approximately $n + 1$. This accounts for the peculiar cross-like shape of the diffraction pattern. The legs of the cross can be shown to stand perpendicularly to the maximum gradient of the sound track. The intensity is furthermore alternatively given by a sine for even and a cosine for odd orders. This explains the set of equidistant zeros, which may be called p-zeros. An alteration of the modulation q only affects the q-zeros determined by a Bessel function and thus only alters the shape of the cross. Alteration of the width of the zero track $2p$ only affects the distance of the p-zeros determined by a sine or cosine.

The formula (1) given here is the formula for bilateral modulation. If unilateral modulation is used, the trigonometric factor vanishes for all orders but zero, so that the intensity for these orders is given by a Bessel function divided by its argument.

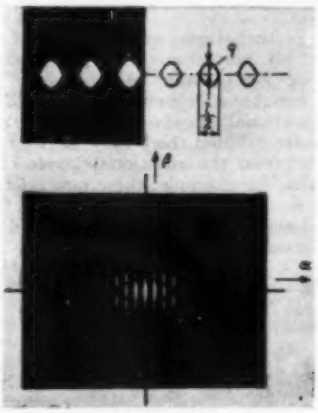

Fig. 2.

If more frequencies are present in the sound, the intensity along the α-axis is again identical with the intensity obtained by variable-density film and thus provides a visual Fourier analysis of the sound.

An interesting example is shown in Fig. 2. The width of the track is $q \sin 2\pi x/l$ from 0 to $l/2$ and zero from $l/2$ to l. In sound film practice this corresponds to zero value of the zero track. The Fourier spectrum only contains the orders 0, 1, 2, 4, 6, 8 . . . Higher odd harmonics should not be present. Fig. 2 confirms this expectation : along the α-axis only even higher harmonics are present.

For odd orders the intensity is given by

$$\frac{1}{\beta^2} \cdot J^2_{2n+1}\left(\frac{2\pi\beta q}{\lambda}\right) \quad . \quad . \quad . \quad . \quad (2);$$

and thus, but for the trigonometric factor, identical with (1). For even orders, however, the intensity is given by

$$\frac{1}{\beta^2} \cdot \Omega^2_{2n}\left(\frac{2\pi\beta q}{\lambda}\right) \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where Ω_{2n} stands for a Weber-Lommel function of order $2n$. For small values of the argument, Weber-Lommel functions of even order can be represented by the first power of the argument. The intensity along the α-axis is therefore different from zero. For higher values of the argument the behaviour of Weber-Lommel functions is very much like that of Bessel functions, appreciable intensities not being reached for values of the argument lower than the order. The observed zeros are in very good agreement with the calculated ones.

The original idea of Brown has hereby been greatly extended. Whereas the behaviour of variable-density film can be deduced immediately from the theory of optical gratings, this is not the case for variable-width film. It would seem that to the two well-known types of optical gratings, modulation of the amplitude and modulation of the phase of the incident light, a third new type, modulation of the width of the grating, is added.

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[1] NATURE, **140**, 1099 (Dec. 25, 1937).

Specific Heat of Carbon Dioxide at Low Temperatures

A NEW Raman line with $\Delta\nu = 58$ cm.$^{-1}$ was observed by us[1] in the Raman spectrum of solid carbon dioxide at − 80° C. Since the heat capacities of solid carbon dioxide at low temperatures are known[2], it may be of interest to examine whether these values agree with those obtained from a corresponding Debye function. If the value of $\Delta\nu$ of the observed new line be taken as 63 cm.$^{-1}$, in view of the fact that this value increases slightly at low temperatures in other cases, the value of $h\nu/k$ is 90·3°. If the line be due to lattice oscillation, the values of C_v should be given by the corresponding Debye function with three degrees of freedom, because the crystal being cubic, ν has the same value for the three degrees of freedom. The calculated values are given in the second column of the accompanying table, and the observed values of C_p are given in the last column. It can be seen that the former are much greater than the latter at low temperatures. This shows that the new line is not due to a lattice oscillation involving translational motions of the molecules.

T	C_v for D.F., $\theta = 90{\cdot}3$	C_v for two E.F., $\theta = 90{\cdot}3$	C_v for one E.F., $\theta = 90{\cdot}3$ and D.F., $\theta = 168{\cdot}8$	C_p observed
19·4	2·46	0·836	1·08	1·08
22·0	2·91	1·144	1·49	1·45
25·4	3·41	1·524	2·04	2·06
31·8	4·11	2·11	3·04	3·28
37·8	4·55	2·518	3·85	4·38
44·2	4·88	2·838	4·58	5·46

Again, if the new line be assumed to have its origin in angular oscillations postulated by Pauling[3], its contribution to the heat capacity would be equal to that of two Einstein functions corresponding to two degrees of freedom perpendicular to the axis of the molecule. These values, given in the third column of the table, when compared to the observed values of C_p, show that the contribution of some other Debye function, which has to be taken into consideration, becomes superfluous. Hence the new line cannot be due to these angular oscillations.

The contributions to C_v of one Einstein function with $\theta = 90{\cdot}3°$ and of a Debye function with three degrees of freedom and with $\theta' = 168{\cdot}8°$ agree fairly with the observed values of C_p, as can be seen from the last two columns of the table. The observed values of Cp at higher temperatures are higher than

the calculated values of C_v, probably because the value of $C_p - C_v$, and also the contribution due to angular oscillations, become appreciable. The observed heat capacities therefore show that, besides the lattice oscillations, another oscillation responsible for the origin of the new line takes place at low temperatures, the nature of the oscillation being such that its contribution to C_v is that of the corresponding Einstein function. It appears that this oscillation takes place in pairs of carbon dioxide molecules, the molecules in each pair being connected to each other by a weak electronic bond.

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[1] Sirkar, S. C., and Gupta, J., *Curr. Sci.*, **5**, 214 (1937).
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Structure of the Methane Molecule

AN explanation of the complex rotational fine structure of the 1306 cm.$^{-1}$ fundamental vibrational band of methane[1] has been found which is based on a tetrahedrally symmetrical model for the molecule. The cause of the splitting of the rotational lines is a Coriolis coupling between the rotational levels of this threefold degenerate mode of vibration ν_4 and the rotational levels of the infra-red inactive twofold degenerate vibration ν_2 at 1536 cm.$^{-1}$, which lies 230 cm.$^{-1}$ above it. The perturbation is appreciable in spite of the distance between the pairs of levels concerned, because the Coriolis coupling term in question is essentially a first-order term in the Hamiltonian. A general expression for this term in methane was given by one of us in a previous paper[2]. It involves the components of vibrational angular momentum obtained by combining the displacements of ν_4 with the momenta of ν_2 and *vice versa*[3]. It is to be noted that since the two vibrations belong to different symmetry types, the perturbation affects only the rotational levels and leaves the origin of the ν_4 band unaltered.

The perturbation, which produces a splitting as well as a displacement of the rotational levels, has been calculated up to the tenth rotational quantum number. From these perturbed levels a theoretical spectrum has been derived which agrees very well with the observed spectrum, even though we have not taken into account any change in the moment of inertia or any centrifugal expansion of the molecule. These latter effects are therefore probably small. It should be pointed out that theoretical intensities which take into account correctly the nuclear spin weights of the equivalent hydrogen nuclei have not been given before. We have made use of the recent work of Maue[4] to calculate these, and the theoretical intensities agree well with experiment (for example, $R(1)$ and $R(5)$ weak).

It is to be noted that when, as in the low-frequency fundamental of methane, the perturbation comes from above, the levels are all pushed down. This produces, since the perturbation increases with the rotational quantum number, a converging R branch, a diverging P branch and a broad Q branch which extends well into the P branch, thus producing the effects of an apparent increase in the moment of inertia. A perturbation from below would, however, produce just the opposite effect, namely, a divergence in the R branch, a convergence in the P branch and a Q branch extending into the R branch. The fundamental ν_4 of germane (GeH_4) does indeed appear to have this structure[5], and we have here just the required conditions to produce this effect, for the perturbing vibration ν_2 lies below ν_4 (Steward and Nielsen[6] give $\nu_4 = 934$ cm.$^{-1}$, $\nu_2 = 820$ cm.$^{-1}$) (In silane (SiH_4), on the other hand, the Q branch would appear to extend into the P branch[6] and this is in agreement with the assignment of the frequencies ($\nu_4 = 910$, $\nu_2 = 978$) given by Stitt and Yost[7] which makes the perturbation come from above. We would like to believe that the apparent additional Q branch found near 978 cm.$^{-1}$ in the 910 cm.$^{-1}$ band of silane comes from activity being imparted to ν_2 by the perturbation.)

Similar perturbations may be expected in the spectra of all polyatomic molecules possessing a threefold or higher axis of symmetry, for such molecules can have degenerate modes of vibration with a vibrational angular momentum, and if the conditions are fulfilled there may be a large Coriolis coupling between the rotational levels of different bands. Thus, for example, these new effects may be looked for in the perpendicular bands of the methyl halides and ammonia and possibly in the deformation bands of linear molecules.

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[2] Jahn, H. A., *Ann. Phys.*, **23**, 529 (1935).
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Photographic Action of Artificial Radio-Elements

IN the literature concerning artificial radioactivity, we find no indication of attempts to show the photographic action of radio-elements. Accordingly we decided to carry out a few experiments, the results of which are given below.

(*a*) Fig. 1. (*b*)

It is known that iridium irradiated with neutrons slowed down in paraffin shows a strong activity of period 19 hours. We placed an activated sheet of

iridium directly on the emulsion of a photographic plate (Gevaert Super-Press 2,000). After 21 hours, development showed a neat photographic blackening (Fig. 1*a*). Similar attempts were repeated, arranging on the plate two similar iridium sheets, one irradiated, the other not so. The blackening was found only under the irradiated sheet. In subsequent attempts, the sheet was separated from the emulsion by interposing thin aluminium screens arranged in steps of increasing thicknesses : a blackening was found again, the intensity of which changes with the interposed thickness.

One of us (J. G.), having obtained a strong source of radio-phosphorus [1], an exposure of this kind of 48 hours was made with radio-phosphorus ; it gave the result shown in Fig. 1*b*. The copper rod covered with radio-phosphorus was about 1 mm. distant from the emulsion.

These first attempts show undoubtedly the photographic action of artificially produced radio-elements.

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[1] Govaerts, J., NATURE, **141**, 871 (1938).

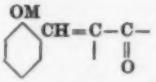
Specificity of the Salicylaldehyde Reaction of Csonka-Straub

A SHORT time ago, Prof. A. E. Braunstein[1] discussed the specificity of the salicylaldehyde reaction proposed by Csonka for the determination of acetone and by Straub for the determination of pyruvic acid, and suggested that a positive reaction is obtained with all compounds containing a CH_3CO group linked directly to a hydrogen or carbon atom, and that the reaction is negative with carbonyl compounds which do not contain the aforementioned grouping. The mechanism responsible for this range of specificity was stated to involve the possibility or otherwise of enolization ensuing in a strongly alkaline medium, leading to the formation of an enolate the colour of which was attributed to a cumulated double bond system.

On this view, ethyl acetoacetate, which gives a positive reaction, must condense through its methyl group and not through its reactive methylene group—a most unlikely occurrence (compare the formation of salicylacetylacetone from salicylaldehyde and acetylacetone). Positive results have been obtained in the salicylaldehyde test with diethyl ketone, propionaldehyde, cyclohexanone and methyl cyclohexanone, all of which on Prof. Braunstein's hypothesis should have given negative results. Prof. Braunstein describes the colours obtained in the test as yellow. While this is true of very dilute solutions, with more concentrated solutions the colours obtained are varying depths of red, changing with dilution through orange to golden-yellow. The limit of detection is attained when the red tint fails to deepen appreciably the lemon-yellow colour given by salicylaldehyde in alkaline solution. Employing a relatively concentrated acetone solution (a few drops in 5 ml. water) in the test, there separate out on prolonged standing dark red prisms with a green metallic lustre, using sodium hydroxide, or glistening bright red leaflets using potassium hydroxide. These have been shown to be the simple alkali salts of salicylacetone (sodium content 12·3 per cent). In very dilute solutions, where there is a large excess of salicylaldehyde, it is, of course, probable that disalicylacetone is also formed.

Similarly, benzalacetone yields a dark red sodium salt giving sodium 8·7 per cent. Acetophenone gives vermilion-coloured needles which on acidifying yield salicylacetophenone. The positive results given in the test by cyclohexanone and 1-methylcyclohexanone are supported by the observations of Borsche and Geyer[2] that the condensation products from salicylaldehyde and cyclohexanone and 4-methylcyclohexanone respectively give red solutions in alkali.

The mechanism of the colour reaction thus involves condensation of the salicylaldehyde with a methylene group in the α-position to an unsaturated group such as carbonyl (CO) and the formation of a simple alkali salt of the resulting compound. The chromophoric grouping is therefore



where M is Na or K. The function of the carbonyl group is to activate the adjacent methylene group. Positive results have been obtained with a 3 per cent solution of cyanacetic acid, in which the methylene group is activated by the unsaturated —C≡N group. Negative results have been obtained with fluorene, the methylene group of which possesses a certain amount of activity, no condensation taking place in this instance.

The range of specificity of the salicylaldehyde reaction is thus by no means so narrow as stated by Prof. Braunstein and the enolization mechanism is untenable. The test is more sensitive for acetone than for any of the other substances examined, which included pyruvic acid, ethyl acetoacetate, acetophenone, benzalacetone, acetaldehyde, propionaldehyde, methyl ethyl ketone, diethyl ketone, cyclohexanone, methylcyclohexanone and cyanacetic acid.

It is hoped to publish full details of the investigation elsewhere in due course.

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[1] Braunstein, NATURE, **140**, 427 (1937).
[2] Borsche and Geyer, *Annalen*, **393**, 49 (1912).

A New Method of Resolving a Racemic Compound

SINCE the introduction of Tswett's technique of chromatographic adsorption, this process has been applied successfully to the separation of many isomeric or closely related substances, including the chlorophylls and the components of natural carotene. A few attempts have also been made to employ it for the resolution of racemic compounds by use of an optically active adsorbent, but without positive results.

After examining a number of cases, we have now succeeded in effecting a partial resolution of inactive *p*-phenylene-*bis*-iminocamphor, $C_{10}H_{16}{:}N.C_6H_4.N{:}C_{10}H_{16}$,

in the following manner. A weak solution of the compound in petroleum-benzene mixture (8 : 1) was allowed to flow down a tube filled with solid lactose, when the compound was adsorbed forming a broad pale yellow band in the upper part of the tube. The adsorption band was then 'developed' by washing it with the same solvent mixture until the faintly coloured layer practically filled the tube. On pushing the lactose column out of the tube, dividing it into four quarters and recovering the adsorbed material from the top and bottom fourths, respectively, by extraction with chloroform, a partial resolution was found to have occurred. *d*-*p*-Phenylene-*bis*-iminocamphor is more strongly adsorbed on lactose than its lævorotatory isomeride, and the product recovered from the upper fourth gave after purification from a trace of lactose, $[\alpha]_D + 90°$ (in chloroform): the product from the lower fourth had $[\alpha]_D - 50°$, both values remaining unchanged after further crystallization. As pure active *p*-phenylene-*bis*-iminocamphor has $[\alpha]_D \pm 1{,}500°$, the above process represents a separation of the dextro form in about one sixteenth of its maximum optical purity. Experiments are in progress with the object of increasing this degree of separation. When completed, the details will be published elsewhere.

As is well known, the success of chromatographic adsorption methods rests largely upon the correct choice of solvent and adsorbing medium. The facts recorded above thus open the way to further investigations which may lead to the discovery of cases in which resolution is more readily achieved. The method has the advantage that it is not dependent upon the presence in the asymmetric molecule of a carboxyl, amino or other chemically reactive grouping.

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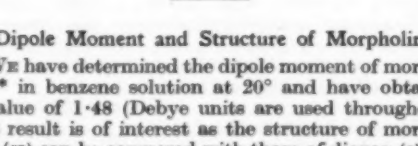
Dipole Moment and Structure of Morpholine

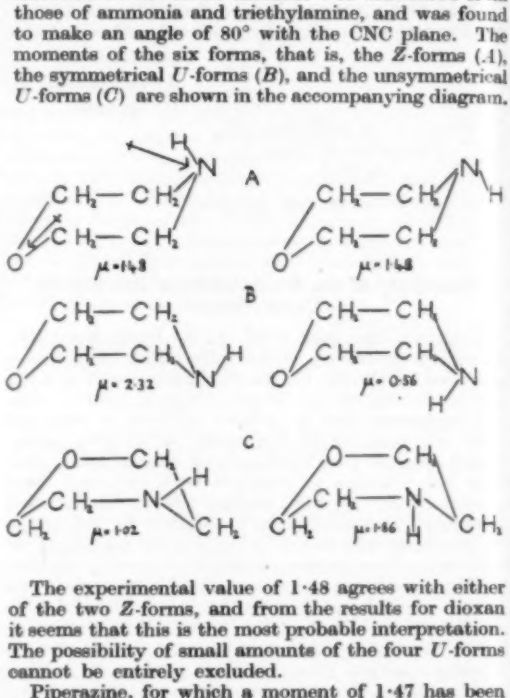
We have determined the dipole moment of morpholine* in benzene solution at 20° and have obtained a value of 1·48 (Debye units are used throughout). The result is of interest as the structure of morpholine (II) can be compared with those of dioxan (I) and piperazine (III).



I II III

There are three possible configurations of the six-membered dioxan ring[1]. The Sachse *Z*-form would have zero moment, while the moment of the symmetrical *U*-form would be approximately 2, and that of the unsymmetrical *U*-form would be approximately 1. The experimental value of the moment of dioxan is 0·4–0·5, both in benzene solution and in the vapour state[1,2]. Kubo[1] concludes that dioxan exists in the *Z*-form, but there may be a small amount of either of the *U*-forms present.

In the case of morpholine, there are two possible *Z*-forms and two symmetrical *U*- and two unsymmetrical *U*-forms, because in each case there are two positions which the hydrogen atom attached to the nitrogen can take up with respect to the rest of the molecule. We have calculated the moments of the six forms using atomic distances and angles from recent work on electron diffraction[3]. The moment of ether (average value 1·18) has been used for the group moment and that of diethylamine[4] (1·13) for the moment. The direction of the latter moment was calculated from those of ammonia and triethylamine, and was found to make an angle of 80° with the CNC plane. The moments of the six forms, that is, the *Z*-forms (*A*), the symmetrical *U*-forms (*B*), and the unsymmetrical *U*-forms (*C*) are shown in the accompanying diagram.



The experimental value of 1·48 agrees with either of the two *Z*-forms, and from the results for dioxan it seems that this is the most probable interpretation. The possibility of small amounts of the four *U*-forms cannot be entirely excluded.

Piperazine, for which a moment of 1·47 has been found in benzene solution by Martin and Partington[5], is an analogous compound for which there is a larger number of possible configurations. Assuming a *Z*-form of ring for this compound, and that all positions of the hydrogen atoms are equally probable, calculation gives a value of 1·52, in good agreement with experiment.

The complete results will shortly be published.

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* Specimen kindly given to us by the General Metallurgical and Chemicals, Ltd.

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Biological Sciences

Halteres of Flies as Gyroscopic Organs of Equilibrium

In insects belonging to the group Diptera the second pair of wings is modified into a pair of dumb-bell shaped organs, called halteres or balancers, which consist of a thickened base bearing numerous sense organs, a shaft, and a swollen blood-filled end (Fig. 1, A). During flight the halteres are vibrated rapidly through an arc of about 90° in the vertical plane with a frequency which is almost certainly identical with that of the wing beat. In *Calliphora*, *Lucilia* or *Phormia* this is about 200 times per second.

It has been known for a long time that without halteres the insect cannot fly, but otherwise behaves normally. Until about twenty years ago, this was attributed to the inability of the animal to maintain its equilibrium in the air, but v. Buddenbrock (1917, 1919[1,2]) rejected this view, and regarded the halteres as "stimulation organs" (*Stimulations-organe*) which served to stimulate the central nervous system into a state of activity indispensable for the execution of the flight movements. We have come to the conclusion that v. Buddenbrock's conception of a purely stimulatory function for the halteres is wrong and that the old balancer theory is in principle correct. The following are the main points of the experimental evidence:

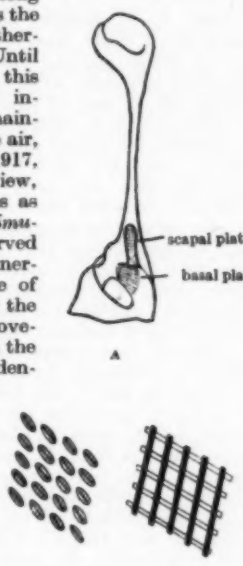

Fig. 1.

(1) In flies deprived of their halteres, flight can always be induced through the so-called flight reflex, that is, by lifting the fly off the ground and suspending it freely in the air[3]. Certain species (*Phormia terra-novae R.-D.*, *Lucilia sericata* Mg.) fly under these conditions for as long as normal flies.

(2) It is confirmed that immediately after removal of the halteres the flies do not take to flight spontaneously and cannot be startled as readily as normal flies. But they become almost indistinguishable from normal individuals in this respect when tested one day after the operation. This suggests that the temporary loss of spontaneity is caused by a shock effect.

(3) The amplitude and frequency of the wing beat after the operation are identical with those of normal flies.

(4) Flies without halteres show a complete loss of control in the air and often fall on their backs, whereas those which are merely fatigued or have had their wings clipped fly downwards steadily and alight perfectly.

(5) This loss of control is particularly marked with regard to rotations about a vertical axis. Flies suspended freely from a piece of thread in the normal position spin irregularly round this axis.

(6) The loss of equilibrium in a fly without halteres can be almost eliminated by fixing a piece of cotton to the tip of the abdomen. This stabilizes the flight and largely compensates for the loss of equilibrium otherwise observed.

The mechanism by which the haltere acts as an equilibrium organ can be deduced from a study of the anatomical arrangement of the sense organs at its base. The most numerous type of organ present is the campaniform sensillum, the mode of action of which has recently been described by one of us (Pringle, 1937[4]) from experiments on the cockroach. On the legs of that insect the sensilla were found to be sensitive to the shearing strains set up in the exoskeleton by muscular activity, and a theory was developed to relate this behaviour to the structure of the sensillum.

The arrangement of the sense organs of the haltere base has been described accurately by Pflugstaedt (1912[5]). On the basal plate the sensilla, each of which consists essentially of an oval hole in the exoskeleton bridged over the top by a thin membrane, lie in regular rows and show a definite orientation in a direction which is diagonal to the length of the haltere (Fig. 1, B). The cuticle of this plate is so pierced with sensilla that its mechanical properties can differ little from those of a trellis (Fig. 1, C), which is relatively strong or weak in shear according as the resulting lines of compression and extension lie parallel to or diagonal to its component strips.

In flight the vertical vibration of the halteres will produce forces in the skeleton of its hollow base, and these will normally be of the type to which the basal plate is most resistant. Further, the sensilla of the plate, owing to their diagonal orientation, should be insensitive to such forces (Pringle, 1937[4]). If, however, while the halteres are in rapid movement, the whole body of the insect is rotated in any plane not that of the haltere vibration, lateral shearing forces will be set up in the cuticle of the base due to the gyroscopic action of the end knob; and to these the basal plate should be least resistant and its sensilla most sensitive. The secondary forces due to the rotation will alternate at a frequency related to that of the haltere beat, and the sensilla will be excited at each cycle.

The haltere may thus be regarded as an alternating gyroscope, and the two organs, which are inclined backwards on each side at an angle of about 60° to the long axis of the body, could act together as an efficient equilibrium organ for fore-and-aft and directional stability. The experimental work shows that it is particularly in these planes of movement that balance is impaired by haltere removal.

The substance of this communication will be further discussed in separate papers dealing with its different aspects.

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Salinity Tolerance and *p*H Range of *Culex fatigans*

In a paper on the biology of *Culex fatigans* Wied. in the Belgian Congo, Drs. Wanson and Nicolay[1] state that "at Banana the larval cycle is accomplished normally in concentrations of up to 30 grams of chloride per litre". Taking this figure as representing the total chlorides present, the salinity, (S°/$_{oo}$), expressed as total weight of salts in grams per 1000 gm. of sea water, would be in the vicinity of 33·5. Hamlyn-Harris[2] states that in Queensland this mosquito rarely breeds in brackish water. No other references to *Culex fatigans* Wied. breeding in saline waters have been found, and it is generally regarded as a typical freshwater mosquito.

In a recent series of experiments carried out at Sydney, laboratory cultures of *C. fatigans* were reared in various dilutions of sea water, using tap water as a control.

The general technique of breeding was similar to that previously described by me[3].

It was found that larvæ would not develop normally in water with a salinity greater than 10 gm. per 1000. Where the salinity was very gradually raised during larval development, about 60 per cent of adults emerged from S°/$_{oo}$ 11, about 15 per cent from S°/$_{oo}$ 12, and none from S°/$_{oo}$ 16. When first stage larvæ were transferred directly from S°/$_{oo}$ 0 to S°/$_{oo}$ 12, all died within a few days. Fourth stage larvæ transferred directly from S°/$_{oo}$ 0 to S°/$_{oo}$ 12 gave approximately 1 per cent of adults, and no adults emerged from large series transferred to S°/$_{oo}$ 13·5.

All control series gave 100 per cent adults. Pupæ, on the other hand, transferred from S°/$_{oo}$ 0 to S°/$_{oo}$ 70 gave 100 per cent adults, while from S°/$_{oo}$ 105, 85 per cent adults emerged. It will be seen from this that the pupæ are extremely resistant to high osmotic pressure in the surrounding medium.

With regard to the hydrogen ion concentration, the *p*H was lowered by the addition of dilute acetic acid to tap water, and it was found that 100 per cent of adults would develop from larvæ bred in water the *p*H range of which varied from 3·6 to 4·2. Similarly, by the addition of dilute sodium hydroxide, adults developed normally from larvæ kept in water which varied between *p*H 9·0 and 10·6. It may therefore be concluded that the hydrogen ion concentration in itself has no effect on the development *C. fatigans* within the limits of *p*H 4·2 and *p*H 9.

A detailed account of the experiments on salinity and hydrogen ion concentration will be published shortly.

In view of the importance of *C. fatigans* as a pest species and as a vector of disease, it would be interesting to know whether any other workers have records of it breeding in salt water. Possibly a salt water race of this species occurs on the coast of the Belgian Congo.

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[1] Wanson et Nicolay, *Ann. Soc. Belge Med. Trop.*, **17**, No. 1, 111 (March 1937).
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Cytology of Metamorphosis in the Culicinæ

PROF. C. A. Berger[1] has apparently overlooked the work of Holt[2], who also investigated the larval gut of *Culex pipiens* during metamorphosis, and described multiple chromosome complexes of 9, 12, 18, 24, 36, 48 and 72 chromosomes. Holt's results do not agree with Berger's conclusion that there is a correlation between chromosome number and cell size in this case, and her illustrations show conclusively that any such correlation is fortuitous. Holt also describes the so-called 'prophase synapsis' of the sister chromosomes of the complex, which pair in three groups ($n = 3$), but she says that the cells with the largest multiples contain vacuoles and show signs of degeneration, and that these cells ultimately degenerate, and are absorbed by the newly formed imaginal cells.

Actually, this synapsis is somatic pairing[3], which was most strikingly shown in Diptera, and especially in *Culex*, by Metz[4], and was first found by Stevens[5]. It is due to attraction between homologous chromosomes, which results in close approximation, but any appearance of fusion is due, Metz showed, to faulty fixation. The chromosomes are not closely coiled round each other, and therefore those torsion stresses which are essential in the production of chromatid breakage and chiasma-formation[3] are not present, and reduction by the ordinary mechanism of meiosis is impossible. Holt believes that the close somatic pairing of the multiple chromosome complexes finishes before the end of prophase, and mitosis is normal. Even were it to persist to metaphase, it would not lead to regular reductional separation, as is demonstrated by the work of Ribbands[6] on the hybrid *Lilium* × *testaceum*, where position correlation of univalents at diakinesis usually leads to their parallel secondary pairing at prometaphase, but nevertheless the distribution of the univalents towards the opposite poles at full metaphase is random.

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May 7.

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Bionomics of a Cattle Louse

In the course of a study of the life-histories and bionomics of cattle lice, I have found that the species *Solenopotes capillatus*, End., hitherto considered to be rare in Great Britain, is more common than has been supposed. I found the species first on dairy shorthorn cattle (cows, heifers and calves) at the Cooper Field Research Station, Little Gaddesden, Herts, and further investigations in the neighbourhood revealed the presence of this louse on three other farms. It thus appears that there is a high incidence of *S. capillatus* in Hertfordshire.

While engaged on field work in Scotland in April of this year, I was able to find these lice on cattle at three out of a total of seven farms, where I made examinations. This, I believe, is the first record of the occurrence of *S. capillatus* in Scotland. The localities of the three farms were Strathyre, Perthshire, and Bentpath and Langholm, Dumfriesshire.

These records prove to be more interesting when it is added that examinations conducted on thirteen farms disclosed the presence of *Bovicola bovis* on eleven, *Hæmatopinus eurysternus* on eight, *Linognathus vituli* on five and *Solenopotes capillatus* on seven. The species of sucking lice were confined to nine only of the thirteen farms, which fact signifies a relatively high incidence of *S. capillatus*. With a single exception, the infested cattle were all dairy shorthorns, and the parasites were found on both sexes of all ages, that is, bulls, cows, heifers, bullocks and calves.

The original record and description of *S. capillatus* was made by Enderlein[1] in Germany. Bishopp[2] recorded the species in the United States, where this louse appears to be widely distributed. The earliest record of the occurrence of the species in England (Cornwall) appears to be that of Noel Pillers[3]. Australian records are those of O'Connor[4] (Perth, W. Australia) and McCulloch and Noble[5] (New South Wales). Freund[6], who redescribed this insect in Germany, gives a detailed description of the external anatomy, comparing his observations with those of Bishopp.

The available evidence suggests that *S. capillatus* is widely distributed, and is possibly more important than has been supposed, and, further, that this louse should be included with the other three well-known species attacking cattle, when considering control measures.

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Succession in Birthcoat Kemp Follicles

Dr. A. B. Wildman[1], communicating the findings of the late Prof. J. E. Duerden, has recently written about the nature of the successors of birthcoat kemp in the merino, pointing out especially that an original kemp is sometimes followed, in the same follicle, by a fine non-medullated fibre.

In dissections of Romney skin taken about ten weeks after birth, a hair-cone has been found below a club-hair birthcoat kemp. In 1931 at this College, Miss Anthea Hefford showed, among other facts about sweat glands, that the follicle of a birthcoat kemp always possessed a sweat gland, but not so the newly developed follicle of a fibre added to the fleece in the early months after birth. At ten weeks, follicles with sweat glands were found with the tip of a new fibre just protruding from the wide mouth of the follicle. New fibres, similarly short, in follicles lacking sweat glands, were closely gripped by the sheath surrounding the emerging tip. At three months, non-medullated fibres, an inch or a half or so shorter than the long persistent birthcoat fibres, were found in follicles with sweat glands attached. The freedom from medulla of the successors of birthcoat kemps is brought home on examining in the benzol tray specimens from certain covered lambs in which the shed birthcoat kemps stand out at the tip of the staple, while below there is no medulla at all, or just a touch of it in the apical ends of fibres far fewer than the birthcoat kemps.

Differences in the nature of the successors (G_2) of birthcoat kemps (G_1) have been studied, especially on the middle of the back at the level of the attachment of the last rib[2]. For simplicity attention may be focused upon the successors of the largest birthcoat kemps, the halo-hairs, in fibre type arrays containing sickle-fibres, although a parallel story could be related for the 'plateau array', which, typically, lacks sickle-fibres. Amongst the immediate successors (G_2) of halo-hairs the presence of a big proportion of kemps is correlated with the shedding of a substantial majority, usually threequarters or more, of the large-ended sickle-fibres. Reasons have been published for attributing the shedding of kemp to vigour on the part of the follicle.

When there is little G_2 kemp, it has been concluded that the hairiness (medullation) of the persistent successors can, in some measure, be correlated with degree of freedom of shedding of the large-ended sickle-fibres, but that the medullation of these successors tends also to reflect that of large persistent birthcoat fibres, the curly-tip fibres.

Following the G_2 'crop' of kemp there may be another, or even two more crops of secondary kemps grown before the first shearing at some fourteen months. Such later kemp has been found in any abundance only in lambs in which the fibre type array is 'saddle', or a near approach to that array. Such an array is indicative of a mild pre-natal check. In the 'valley array' the pre-natal check is intense. In this array there is much G_2 kemp if halo-hairs are abundant and the large-ended sickle-fibres shed freely, but there is little later kemp (G_3 and G_4). The consequences of a pre-natal event are reaped, it is thus concluded, at the age of nine months.

Preliminary breeding experiments point to genetic factors being of importance in determining the above differences in the 'kemp history' of the fleece of the first year.

Not only does theoretical trichology have practical significance in wool production, but also that somewhat large domesticated animal, the sheep, grows good material for pure zoology.

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[1] Nature, **140**, 893–94 (Nov. 20, 1937).
[2] *N.Z. J. Agric.*, **48** (June 1934).

Acclimatization in Relation to Livestock Improvement

THE problem of the acclimatization of breeds of livestock exported from one country to another is interesting. Certain breeds quickly adapt themselves to certain environmental conditions far removed from those under which they were reared. But, generally speaking, the importation of domesticated breeds into countries of different climatic and soil conditions is regarded as a somewhat risky enterprise. The genetic constitution of the modern breeds has so changed during the last hundred years that many of them depend entirely upon human assistance, and have lost, to a great degree, the ability to live under natural conditions. If this happens in a country, it may be advisable to import foreign breeds of strong constitution which are better adapted than the local breeds, weakened through the continued use of false standards of selection over many generations.

An example of this is to be seen in the Zoological Garden at Warsaw. The European wild deer (*Cervus Elaphus*), from the forests which surround that city, when kept in the open paddocks at the Zoo during the winter, are very susceptible to colds, and usually succumb to pneumonia. On the other hand, the spotted wild deer, imported from India, running in similar paddocks and receiving similar treatment, show signs of robust health and maintain good condition throughout the winter. This observation is confirmed by others and appears to hold good for other Mammalia imported to Warsaw from the tropics.

Accordingly, one is forced to the conclusion that the genotype of the European deer has been weakened. These wild deer of Europe are kept under abnormal conditions. Not only is natural selection removed, but also, since the sportsmen shoot the best males, it is the least thrifty specimens that produce the next generation. These wild deer have to be artificially fed during the winter.

Accordingly, consideration of the problem of acclimatization of domesticated animals in European conditions must include the weakened condition of domesticated strains. It appears to me that this emphasizes the need for skilful selection on the part of the breeder of these domesticated strains, and that this is a more important factor in economical production than suitable environmental conditions. But, of course, the progressive breeder will make his choice of the right breed in its right environment.

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Sources of Calcium for Shell of *Ostrea virginica*

THE letter by Robertson and Pantin on "Tube Formation in *Pomtoceros triqueter* (L)"[1] points to the sea water as the source of the calcium required for the building of tubes. It is of interest that a similar condition apparently obtains in the case of *Ostrea virginica*. My observations in 1932–33[2] on the growth of oysters in Long Island Sound show that the deposition of the shell material continues throughout the winter even when other activities of the organism are reduced to the minimum. The weight of the shell increased when the temperature of the water dropped below 4° C. and the oysters were in a state of hibernation, unable to take in any food. During the same period the weight of the tissues remained constant. In view of the fact that there is no storage of calcium in the body of the oyster, an inference can be made that calcium and other salts required for the building of shells are taken in directly from the sea water.

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[2] "The Biochemistry of the Invertebrates of the Sea", by Paul S. Galtsoff, *Ecological Monographs*, **4**, 481–490 (October 1934).

Toxicity of Mercury Vapour to Insects

Christensen, Krogh and Nielsen[1] have referred to the highly toxic effects of mercury vapour in a closed experimental chamber, and recorded the effects on mammals of this vapour arising from droplets of mercury spilled accidentally on the chamber floor. Previously Krogh[2] found a very high mortality among insect embryos on which he was carrying out respiration experiments. He attributed this to the toxic action of mercury vapour from minute drops of mercury which were always left in the tap-borings of his air sampling tubes. He states that it was known from unpublished observations of the Copenhagen physiological laboratories that mercury vapour was highly toxic to insect eggs. Burkholder[3], who cited Krogh's paper, found that eggs of the grasshopper, *Melanoplus differentialis* Thomas, died in a glass respirometer which had been calibrated with mercury although the mercury had been removed prior to the experiment.

Whilst carrying out toxicity tests on eggs of the bed-bug, *Cimex lectularius* L., in a fumigation apparatus containing mercury, I observed a high mortality amongst the controls. At 23° C. all the control eggs were killed in less than twelve hours. I traced this to the effect of mercury vapour, and found that other stages of the bug were only affected after several days' exposure. I also found that eggs of the flour beetle, *Tribolium confusum* Duv., were all killed within less than twenty-four hours, whereas other stages of this insect were unaffected by exposures of one week.

As mercury is extensively used in biological apparatus and the literature concerning its toxicity is very scattered, a note on the subject may be useful to other workers. The literature cited here does not pretend to be exhaustive, as observations on this phenomenon made by physiologists are not necessarily indicated by the title of the paper in which they are mentioned or noticed by abstractors.

Kunhi Kannan[4] first directed attention to the custom of Indian peasants of protecting stored pulses from pests by placing a drop of mercury in an excavated soap-nut in the receptacle used for storing. Though the practice had nearly died out, he investigated it and his results showed the value of what had long been regarded as a superstition. He pointed out that the action of the mercury vapour was only on the eggs of the insects concerned. Larson[5], acting on a suggestion of Kunhi Kannan's, found that both eggs and young larvæ of *Bruchus quadrimaculatus* F. were killed by exposure to mercury vapour. Dutt and Puri[6] confirmed the statement that it was insect eggs that were particularly affected, finding it true of several species of stored products pests and other insects. A dust containing metallic mercury as the toxic principle was found to be effective against pests of cereals by Cartwright[7].

On the other hand, Bovingdon[8] found no detectable difference in the results of fumigation experiments on adults of *Calandra* spp. and *Tribolium* spp., some of which were exposed to mercury vapour and others which were not. In the latter, the mercury vapour was trapped by passing the gas mixture containing it over gold foil.

There seems to be ample proof, however, that mercury vapour is highly toxic to insect eggs. Though other stages are not so seriously affected, it would probably be wisest to avoid the use of exposed mercury altogether in experimental work with insects and possibly other organisms.

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Blood Groups and Pigmentation

THE physical characters of the population of Rachrai (Rathlin Island, Northern Ireland) have already been described[1] and compared with those of the people of Sheffield[2].

A recent survey of the blood groups of the two peoples shows significant relationship between the stages of evolution of the blood group genes and those of the factors for hair and eye colour. Observations of blood grouping and of hair and eye colour were made on thirty males in Rachrai—there are some hundred and fifty on the island. The distributions of hair and eye colour conjointly agreed very closely indeed with those found at the first survey. One third were blue-eyed, one third had fair (blond) hair. One third were of the *RR* (or *O*) blood group, one third were *B* or *AB*. In Sheffield, one half were of the *RR* group, one tenth were *B* or *AB*; one half had fair hair, one quarter were blue-eyed. The Sheffield observations were made on more than three hundred individuals, both for blood and for hair and eye colour. Appropriate statistical tests showed that the populations differed significantly in the distributions of the characters named.

These observations agree with a formula of connexion between the proportions of fair hair (h), pure blue eyes (e), *RR* blood, and *B* (including *AB*) blood, namely:

$$\frac{e}{h} = P\frac{B}{RR},$$

where P is a parameter defined by the inequality: $1 < P < 3$. This formula is derived from a consideration of the genetic nature of the characters concerned, together with their reputed order of sequence in evolution. For Rachrai, P has the value 2·1; for Sheffield it is 2·4. The classification of eyes into blue and others, and of hair colours into fair and others, is based upon published studies upon the post-natal development of the Sheffield population[3, 4], in which such a classification was found to have significance.

An account of the work outlined above will be published in full.

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The Jump of Fleas

I CAN find nowhere any reference to an interesting peculiarity about the jump of fleas, though perhaps it may be common knowledge among those who train them to perform.

While I was studying in the Department of Entomology of the London School of Hygiene and Tropical Medicine, I observed a number of fleas jumping. They were contained in a petri dish and were watched under a large hand lens.

It casually occurred to me as I looked down on a stationary flea that its body was streamlined, but that the fat heavy end was its tail. Arguing from the flight of a dart, which will turn and fly point forward however it may have been thrown, I considered that a flea should travel tail first through the air.

It was an easy thing to check as fleas were all the while coming and going across my field of vision. I watched those that were landing and saw that they were in fact invariably facing the direction from which they had come.

Continuing, I noticed that a flea needs a space of about one to two inches in the air clear of obstructions for the process of turning its heavy end to the front, after jumping off. If it hits something during this part of the leap, it lands sideways and usually falls over. But if not interrupted, the leap carries the insect so that the first parts of its body to touch anything are the two back legs, which are carried in a convenient position ready for landing tail first.

If the landing place proved uncongenial, I suppose nothing could get away more quickly than a flea, already facing as it is the way it wishes to return.

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Fertile Haploid Sectors by Partial Merogony in Mozaics of *Drosophila pseudo-obscura*

A STRAIN of *D. pseudo-obscura* gives a high proportion of mozaic offspring. In the majority of those obtained, only the *X*-chromosomes of the parents were marked and the phænotype of the mozaics consisted of a regular area showing the expected constitution and an exceptional area (usually less than half) in which the recessive genes of the paternal *X* were expressed. Of the fifty obtained in the first experiments forty-six were female with no suggestion

of male tissue. The fact that they were completely normal as to sex suggested that the exceptional area was haploid in constitution, the complex, $1X : 1A$, being known to be female. In addition, the exceptional tissue showed the greatly reduced size of bristles, eye-facets and wing-cells characteristic of haploid tissue. To test this hypothesis, a series of matings was made in which the autosomes as well as the X-chromosomes were differently marked in the two parents. Six more mozaics, all female, were obtained, and in each of these the genome of the father only was manifested in the exceptional region. This result suggests that the basis of mozaicism in these flies is some peculiarity following fertilization which permits of a division of the sperm nucleus before the fusion with the egg-nucleus becomes complete, so that a group of haploid cells is formed bearing the paternal genome which eventually form part of the adult fly. (There is also evidence that two separate sperms occasionally take part in development and also that two female pronuclei are sometimes involved, but the mozaics resulting from these contingencies are extremely rare, and are not here considered.)

The importance of these 'merogonic' mozaics lies in the opportunity they may give of studying the maturation processes of haploid germ-cells where the possibility of normal conjugation is absent. That maturation does take place under these conditions is strongly suggested by the breeding results of one of the few mozaics obtained, in which the haploid tissue formed half the abdomen. Her progeny included six patroclinous sterile sons. These were almost certainly not the result of either primary or secondary non-disjunction since our other work on non-disjunctional forms of this species shows that such males are produced in this way only with the greatest rarity. From their occurrence it is therefore inferred that the haploid germ-cells had undergone meiosis, which had resulted in the formation of some gametes containing all the autosomes but no X-chromosome. Such no-X eggs if fertilized by X-sperm would give patroclinous sons lacking a Y and therefore sterile. Moreover, these would form the only class recognizable as to their origin from the haploid or diploid tissue since, when the X as well as the autosomes was included in such gametes at maturation, they could only give rise to offspring of regular phænotype. The exceptional sons therefore probably represent about a quarter of the actual number of gametes capable of producing viable zygotes that had been elaborated from the haploid tissue of this mozaic. As in the case of triploids, there were probably many more gametes, anuploid as to their main autosomes, and hence giving inviable zygotes.

If these conclusions are substantiated by cytological observation on future cases, it will be clear that conjugation itself, or the presence of a chromosome complex capable of conjugation, though indispensable in the diploid germ-cell as a means of orderly segregation, is not, as such, a necessary step in the process of maturation. The lack of it could not therefore be plausibly invoked as an explanation of the failure of maturation to be initiated or to reach completion in species hybrids.

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Staunton on the Wax Insect of China

Sir G. Staunton in his travels, "Embassy to China", published in 1797 in three volumes, describes, in vol. 1 on p. 352, a wax-producing insect that he observed in Cochin-China and not in China proper. He says, "These insects, each not much exceeding the size of the domestic fly, were of a curious structure, having pectinate appendages rising in a curve, bending towards the head, not unlike the form of the tail feathers of the common fowl, but in the opposite direction. Every part of the insect was . . . completely covered with a white powder. The particular stem, frequented by these insects, was entirely whitened by a powder . . . strewed upon it by them. The annexed engraving

will convey some idea of what is here very imperfectly described. The powder was supposed to form the white wax of the East". He says further it is mixed with oils and moulded into candles.

Blanchard, in his "Coccides utiles", 1883, cites Staunton's work in his bibliography pertaining to the real Chinese wax insect, *Ericerus pela*. The engraving of Staunton, reproduced herewith, leaves no room for mistaking his insect for a scale insect, and it is surprising how Blanchard was led into such an error. Through the kindness of the British Consul-General in Chung King, I have been able to obtain some of the Chinese wax insects, which are entirely unlike the species illustrated by Staunton. It seems to me that the insect illustrated by him is probably a Cicad of the family Flatidæ, and what he saw may have been the larvæ of this unknown Cicad.

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Chromosome Numbers in Sugarcane × Bamboo Hybrids

THE sugarcane × bamboo hybrids recently produced at this station (Venkatraman, 1937), provide material for the study of the phylogenetic relationship of the genus *Saccharum* with other grasses. The gap covered by this cross is considerably wider than in the case of the *Saccharum* × *Sorghum* hybrids[1,2], or the *Saccharum* × *Erianthus* hybrids effected in Java[3].

The female parents employed were the two Java canes: *P.O.J.* 213—an interspecific hybrid between *S. officinarum* (Black Cheribon, $2n = 80$) and *S. barberi* (Chunnee, $2n = 82$); and *P.O.J.* 2725—a rather complicated hybrid cane between a number of 'noble' types and the *S. spontaneum* (*Glagah*) of Java. The male parent was *Bambusa arundinacea* Willd., a species which is common in South India.

Root tips of *P.O.J.* 213 showed 124 chromosomes at metaphase, somatic pairing of homologous chromosomes being very apparent. Bremer has reported 62 bivalents at the reduction division of pollen mother cell of this plant. He gives $2n = 106–107$ as the chromosome number of *P.O.J.* 2725[4]. Reduction division is somewhat irregular in this cane, and like a number of other hybrid sugarcanes, it has been known to produce both diploid and haploid gametes. Pollen sterility is very high in both the canes. As the ovules, however, are fertile, these canes have been used a great deal as female parents in the breeding programme at Coimbatore. 72 chromosomes were counted in the root tips of *Bambusa arundinacea*. Root tips of five of the hybrids between *P.O.J.* 213 and *Bambusa arundinacea* showed 96–100 chromosomes and one plant of the cross *P.O.J* 2725 × *Bambusa arundinacea* examined had 90 chromosome. These numbers represent approximately the sum of the haploid numbers of the two parents.

All the *Saccharum* × bamboo hybrids so far examined differ from the *Saccharum* × *Sorghum* hybrids in the fact that whereas the chromosome numbers of the latter indicate that viable embryos are formed from fertilization of both haploid and diploid gamates[5], in the former only those derived from fertilization of haploid gametes were found to be viable. They also differ from the *Saccharum* × *Imperata* hybrids (Janaki Ammal, unpublished), where viability is limited to such embryos as are derived from the fertilization of diploid gametes only.

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[1] Thomas, R., and Venkatraman, T. S., "Sugarcane × Sorghum Hybrids", *Agri. J. Ind.*, **25**, 164 (1930); Venkatraman, T. S., "Sugarcane × Bamboo Hybrids", *Ind. J. Agri. Sci.*, **7** (1937).

[2] Janaki Ammal, E. K., and Singh, T. S. N., "A Preliminary Note on a New Saccharum × Sorghum Hybrid", *Ind. J. Agric. Sci.*, **6**, 1105–1106 (1936).

[3] Rumke, jun., C. L., "Saccharum-Erianthus Bastaarden", *Archief voor de Suikerindustrie in Nederlandsche-Indie*, Deel II (1934). Mededeelingen van het Proefstation voor de Java suikerindustrie, Jaargang 1934, No. 7.

[4] Bremer, "Remarks on the Cytology of Saccharum", *Facts about Sugar*, **24**, 926–7 (1929).

[5] Singh, T. S. N., "Chromosome Numbers in Sugarcane × Sorghum Hybrids", *Ind. J. Agri. Sci.*, **4**, 1050 (1934).

Pedocalic Tendencies in Soils of Southern England

THE late Dr. C. F. Marbut proposed the division of the soils of the world into two primary groups, namely, pedocals and pedalfers. Pedocals are soils developed under climates which are too dry to maintain a continuous downward movement of water to the water table. They therefore contain a horizon of accumulation of calcium carbonate (and sometimes other salts also) in the soil profile, usually in the *B* horizon. Pedalfers are soils developed under more humid climates. They are completely leached and contain no horizon of calcium carbonate accumulation. Thus the steppe and desert soils of the semi-arid and arid regions are distinguished from the podsolic and lateritic soils of the humid temperate and humid tropical climates. It has been generally accepted that the climate of Great Britain is too wet for pedocals to develop. Under free drainage conditions, therefore, horizons of secondary calcium carbonate accumulation should not occur.

Observations on the brown forest soils of Rumania, developed from calcareous loess, were made by me, through the courtesy of Dr. Cernescu of Bucharest, in the spring of 1937. These showed calcium carbonate concretions at the base of the *B* horizon, although brown forest soils should belong to the pedalfer group. This anomalous position led me to make detailed observations of the soils in Berkshire developed from porous calcareous parent materials, since it was thought that the deposition of secondary calcium carbonate might be a function of the calcareous nature of the parent material.

Consequently, pits were dug on the Malmstone (Upper Greensand) and Calcareous Grit formations. The Malmstone soil, developed under mixed broad-leafed woodland and free drainage conditions, revealed small soft calcium carbonate concretions at a depth of 3 ft. 9 in. at the base of the *B* horizon and in the top of the *C* horizon. The soil on the Calcareous Grit, developed under very free drainage conditions, under a stand of Scots pine at least a hundred years old, revealed secondary deposition of calcium carbonate on the upper surface and in the cracks of bands of shattered rock. These occurred at a depth of 15 in. and again at 37 in.

Analytical data showed that the Malmstone profile was weakly podsolized, since some alumina had been lost from the surface horizons. Iron oxide was apparently stable, although exceptionally low in amount. The Calcareous Grit profile showed lateritic tendencies, since there was considerable loss of silica from the soil horizons. The silica-sesquioxide ratio is about 2·0 in the soil horizons and about 3·0 in the parent material. It is suggested in this connexion that all red-brown soils developed from calcareous parent material may show loss of silica from the soil horizons.

Observations on shallow downland soils near Wantage, developed from Upper Chalk, revealed secondary deposition of calcium carbonate at a depth of 6–8 in., the horizon being about 3 in. deep. The profile was calcareous to the surface, high in organic matter, with a good crumb structure, and showing the typical profile of an English rendzina. Chalk rock fragments occurred throughout the profile, but whereas these are normally humus-stained and therefore dark brown in colour in the soil, the secondary calcium carbonate, which was structureless, showed up as a white layer. This layer was very intermittent, frequently entirely absent, and in places only represented by isolated spots. I consider, however, that this profile strongly resembles the Continental *tshernosem* (steppe soil). Its shallowness is, of course, the result of erosion. In some localities the surface horizon may be completely leached of calcium carbonate and may be slightly acid in reaction, but it does not lose its steppe-like character.

Further observations have revealed secondary calcium carbonate in the parent material of Coral Rag, but not in the soil horizons derived from it. A striking example of secondary deposition of calcium carbonate was also observed in the glauconitic greensand of the Upper Greensand formation. In the upper layers of the parent material were numerous concretions of soft calcium carbonate, up to half an inch in diameter, which showed a ringlike structure in cross section. Evidently deposition had taken place around some non-calcareous material. Large amounts of calcium carbonate were also deposited in old root channels and round dead roots, showing up as a very striking white network in the greenish-grey parent material.

I suggest that secondary deposition of calcium carbonate will always occur in southern England when the parent material is calcareous. This calcium carbonate may lie within the soil itself or below it, at a variable depth in the otherwise unaltered parent material. The intermittent nature of the calcium carbonate accumulative horizon is considered to be caused by differences in moisture movements within the soil, due to small differences in the micro-relief, texture, etc. Calcium carbonate is deposited on upper rock surfaces, in cracks in the rock, in old root channels, and in the form of concretions. It is observed that these concretions are often deposited at the depth to which calcium carbonate is leached from the soil; this was also the case with most of the Rumanian soils examined.

It is of interest to note that Dr. C. F. Shaw, chief of the Californian Soil Survey, when on a visit to Great Britain for the Third International Soil Congress in 1935, observed what he described as an "apparent zone of lime accumulation" in a chalk profile in Kent. He goes on to say that this profile showed essentially the characteristics of the soils of an arid region, and ends up by asking "is there a region of arid soils in England?"

Since in England secondary deposition of calcium carbonate has not been observed in soils developed from non-calcareous parent material, I prefer to regard the phenomena in this country as a function of the calcareous nature of the parent material.

FRANCES F. KAY.

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April 12.

Adaptation Energy

ANIMALS continuously exposed to a uniform damaging stimulus (a drug, exposure to cold, excessive muscular exercise, etc.) at first display the symptoms of the 'alarm reaction'[1] and later pass into a resistant phase; sooner or later, however, the power of resistance is exhausted and the symptoms reappear. It has now been found that this third stage of the general adaptation syndrome may be reached more regularly and more promptly by withholding food.

Sixty female rats, two months old, were adapted to a temperature of 1° C., another group of sixty similar rats was treated with 0·2 c.c. of 4 per cent formaldehyde thrice daily, subcutaneously, while a third similar group was forced to run for 15 minutes thrice daily in 12-inch wheel cages rotated at 18–12 revolutions per minute. Six animals of each group were killed after 1, 6, 12, 24 hours and 2, 4, 6, 10, 17 and 22 days respectively. In another series of exactly parallel experiments, the rats were fasted for the last twenty-four hours before they were killed. It was found that fasting intensified the alarm reaction symptoms in the groups killed during the first forty-eight hours of treatment, but did not visibly affect those killed between the second and the tenth day. The rats killed after 17 or 22 days, and fasted, showed a return of alarm reaction symptoms; pronounced thymus and pancreas atrophy, adrenals brown and enlarged, multiple gastric ulcers and hypoglycæmia; while their non-fasted controls showed adrenals rich in lipids, less marked thymus and almost no pancreas atrophy and no gastric ulcers.

The eventual reappearance of such symptoms gives further support to the conception[2] that for adaptation the organism is dependent upon a special hitherto unrecognized type of energy. The present experiments show that while fasting is harmful during the stage of the alarm reaction when adaptation energy is not yet mobilized, and at the onset of the stage of exhaustion when adaptation energy is depleted; yet the animal in the resistant stage learns to perform adaptive functions more economically and with less dependence on the caloric energy derived from food.

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[1] Selye, Hans, NATURE, **138**, 32 (1936); *Brit. J. Exper. Pathol.*, **17**, 234 (1936); *Endocrinology*, **21**, 169 (1937); *Arch. Internat. de Pharmacodynamie et de Ther.*, **55**, 431 (1937).

[2] Selye, Hans, *J. Path. and Bact.*, in the press.

The Piltdown Bone Implement

I IMAGINE that few archæologists who have made a study of palæolithic cultures, will dispute the Abbé Breuil's recent conclusion[1] that bone was much more extensively used in the earlier of these cultures than has been generally supposed. But his claim that the Piltdown bone implement owes its shaping to gnawing "by carnivores or rodents", is not, I think, likely to receive much support. The pointed end, and the butt-end, of this specimen are formed by a considerable number of facets which have every appearance of being produced by man. Some of these facets exhibit what may be termed a 'stepped' fracture, and this, I fear, has caused Breuil to conclude that animal's teeth have given rise to them.

In the experimental shaping of bone with sharp-edged flints and other stones which I carried out years ago, I found that this stepped fracture appeared frequently. A similar type of fracture is shown by certain flints, broken by some form of natural tension, in various deposits. Personally, I regard the Piltdown specimen as affording remarkably clear evidence of having been shaped by man—but I would be much interested to see the bones referred to by Breuil which have been gnawed by carnivores or rodents, and are said to mislead archæologists into believing that these bones are artefacts. I must confess that I am unfamiliar with such specimens.

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[1] NATURE, **141**, 651 (April 9, 1938).

Chemical Identification of Œstrone in Human Male Urine

Laqueur, Dingemanse, Hart and de Jongh[1] first reported in 1927 that œstrogenically active substances could be obtained from the urine of healthy men. The necessity arose shortly afterwards of identifying these active substances chemically. The small amounts in which these active substances occur in adult male urine has so far made this impossible. Dorfman, Gallagher and Koch[2] tried to solve the problem in 1935 by means of comparative biological studies, but such investigations merely produced indications as to the nature of the œstrogenically active substance.

On the average, adult male urine was found to contain 70 international units per litre. If one assumes a biological activity equal to that of œstrone, this represents a substance content of 7 gamma per litre. This figure makes it perfectly clear that the chemical identification of the œstrogenically active substance in male urine can only be brought to a satisfactory conclusion when large amounts of urine can be worked up. Through the intervention of the N. V. Organon-Oss, for which we take this opportunity of expressing our thanks, it has been possible for us to work up 17,000 litres of male urine. The various stages in the process are briefly described in the scheme below. Tests of the œstrogenic activity of the various fractions on castrated mice served as a guide for judging the success of the separation.

In this way we succeeded in obtaining 6 mgm. of a single crystalline substance. This proved to be identical with œstrone.

	Crystals from male urine	Œstrone.
Melting point ..	256–260°	257–261°
Mixed melting point ..	No depression	
Optical rotation [α]D ..	+153°	+160°
Physiological activity ..	0·1γ = 1 I.U.	0·1γ = 1 I.U.

In the melting point determination practically the same crystalline form was observed as with œstrone. The identity with œstrone of one œstrogenically active substance isolated from male urine is definitely established by the above results.

Œstrone, however, is only partly responsible for the œstrogenic activity of male urine. The extract obtained according to the scheme below can be separated into ketonic and non-ketonic fractions. Only a third to a half of the œstrogenic activity passes into the ketonic fraction. We are at present occupied with the chemical identification of the non-ketonic œstrogenic fraction.

PROCESS SCHEME

Urine: extraction of the hydrolysed urine by the usual method and separation of the comb growth promoting substances.

Benzene solution: evaporated to dryness and the residue partitioned between 70 per cent alcohol and light petroleum.

Alcoholic solution: extracted with benzene after dilution with water.

Benzene solution: washed with soda solution, then with sulphuric acid and extracted with 5 per cent sodium hydroxide solution.

Alkali solution: neutralization of the alkali until practically neutral and extraction with benzene.

Benzene solution: evaporated, the residue dissolved in ether, and extracted with 0·1 *N*-sodium hydroxide solution.

Ethereal solution: treated with Girard's reagent.

Ketonic fraction: submitted to several repeated fractional sublimations in a high vacuum at less than 0·0001 mm. mercury.

125–130° Fraction: recrystallized from methyl alcohol.

Œstrone.

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April 7.

[1] *Klin. Wochenschr.*, **6**, 1859 (1927).
[2] *Endocrinology*, **19**, 33 (1935).

Points from Foregoing Letters

ON the basis of the theory of several 'time-scales', and from the fact that the equations of motion for a particle are unaltered in form when the direction of the trajectory of a particle is reversed, Prof. E. A. Milne and C. J. Whitrow conclude that all the other particles in the universe are relatively stationary, and consequently the universe is non-expanding.

Prof. V. V. Narlikar proposes a new boundary-condition. It is in the tensor form and it is satisfied in the one-body problem as solved by Schwarzschild. He deduces from the condition a general result about the motion of a fluid at its surface and shows that this result implies the content of the geodesic postulate.

A discussion of isostasy leads Sir Joseph Larmor to the view that large accumulations of ice at the poles are not possible without an appreciable slowing down of the earth's daily rotation.

Prof. R. Emden points out that the energy content of the air in a room is independent of temperature and concludes that the reason why we heat our rooms in winter is not to add energy but 'entropy'.

A statistical investigation of the number of secondary cosmic rays produced in an iron-screened and unscreened Wilson cloud chamber, divided into five sections by four parallel lead plates 3 cm. thick, is described by Prof. B. Trumpy. From the results obtained he concludes that the soft components of the cosmic rays amount to about 27 per cent at the earth's surface, and that the hard components cannot be electrons.

Graphs showing the intensity of cosmic radiation at various heights near the pole of the earth's magnetic axis as compared with latitude 49° are supplied by Dr. H. Carmichael and E. G. Dymond. The results obtained both with ionization chamber and coincidence counters show that the radiation intensity is about the same, and indicate that cosmic rays of less than 3,000 M.e.v. do not exist in space, or are prevented from reaching the earth by some agency such as a solar magnetic field.

J. G. Daunt and Dr. K. Mendelssohn describe experiments indicating that the surface of a solid in contact with helium II is covered with a helium film through which the liquid is transferred to the lowest available level, the rate of transfer increasing the lower the temperature. From the amount of electrical energy which has to be supplied as current, before any apparent heating is observed in the upper part of a tube immersed in liquid helium II, A. K. Kikoin and B. G. Lasarew estimate that the thickness of the film is about 10^{-5} cm.

Dr. L. Tisza discusses a possible interpretation of the behaviour of helium II on the assumption that its viscosity is due only to the atoms in the 'excited' state, while the remaining atoms, 'condensed' in the lowest energy level, take no part in the dissipation of momentum. He concludes that a temperature gradient should arise during the flow of helium II through a capillary.

By means of a simple ultracentrifuge which dispenses with an optical system and costs only a few pounds, Prof. J. W. McBain and F. A. Leyda have been able to obtain, for the sedimentation velocity of egg albumen, values agreeing with those obtained by means of the expensive Svedberg ultracentrifuge.

Dr. J. F. Schouten describes the behaviour of a strip of variable-width sound film, such as is widely used in sound film practice, as an optical diffraction grating. The two-dimensional diffraction pattern obtained by modulating a pure tone is reproduced. Contrary to the spectrum of variable-density sound film, the spectrum of variable-width sound film contains all higher orders. The intensity along an order is mainly given by a Bessel function of that order.

From comparison of the observed heat capacities of solid carbon dioxide with those calculated from a new line observed in the Raman spectrum of that substance, S. C. Sirkar and Jagannath Gupta conclude that besides the lattice oscillations, another oscillation responsible for the origin of the new line takes place at low temperatures.

The complex rotational fine structure of the low-frequency fundamental vibrational band of methane is stated by Drs. H. A. Jahn and W. H. J. Childs to be due to a new type of perturbation involving a Coriolis coupling between this fundamental and another inactive fundamental of the molecule. A theoretical spectrum has been found which agrees well with the experimental measurements. It is pointed out that similar perturbations are to be expected in the spectra of other polyatomic molecules having a threefold or higher axis of symmetry.

Dr. T. Thomson states that positive results in the salicylaldehyde reaction of Csonka-Straub are not confined to substances possessing a methylcarbonyl (CH_3CO) group, and that therefore the enolization mechanism of the reaction propounded a short time ago by Prof. Braunstein is untenable. The reaction mechanism would appear to involve condensation through an activated methylene group and the formation of a simple alkali salt of the resulting compound.

A partial separation of an optically inactive compound (*p*-phenylene-*bis*-iminocamphor) into its optically active components, by adsorption on lactose in a Tswett column, has been observed by G. M. Henderson and Dr. H. Gordon Rule.

Prof. J. R. Partington and D. I. Coomber have obtained a value of 1·48 Debye units for the dipole moment of morpholine. The results agree with those calculated for a Sachse *Z*-form of heterocyclic ring for this compound, but the possibility of small amounts of the Sachse *U*-form cannot be excluded. The results are in agreement with those for dioxan and piperazine.

Diagrams of the structure of the 'halteres' or balancers (second pair of wings which in some insects are modified into dumb-bell shaped organs) are submitted by G. Fraenkel and J. W. S. Pringle, who disagree with Buddenbrock's conception of them as stimulation organs. The basal plate of the haltere has the structure of a trellis the resistance of which to shear is dependent upon direction, and the authors regard this, together with the end knob, as an alternating gyroscope, which gives the insect in flight fore-and-aft directional stability. They describe experiments to support this view.

Experiments carried out at Sydney by A. R. Woodhill show that *Culex fatigans* Wied. will not develop normally in water containing more than 10 gm. of salts per litre, unlike the previously reported case by Drs. Wanson and Nicolay, who reported normal development in water containing 30 gm.

C. R. Ribbands directs attention to the work of Holt, who investigated the larval gut of the mosquito during metamorphosis, and whose results do not agree with Prof. Berger's conclusion that there is a correlation between chromosome numbers and cell size.

H. J. Craufurd-Benson records the occurrence of *Solenopotes capillatus*, End. on cattle in England and Scotland, and suggests that this louse possesses a greater economic importance than has been suspected.

Dr. F. W. Dry describes various types of fibres which may succeed the coarse birth-coat hairs in Romney lambs. The immediate successors contain a large selection of kemp (coarse fibres) and after these there may be one or even more crops of secondary kemp before the first shearing when the lambs are fourteen months.

Prof. R. Prawochenski reports that the spotted wild deer imported from India, wintering in open paddocks at the Warsaw zoo, are more resistant to pneumonia than the European wild deer from the forests surrounding that city. He considers that the latter strain has been weakened by domestication and false standards of selection.

A significant relation between blood groups (as determined by serological reaction) and colour of the hair and eyes is indicated by observations made by M. A. MacConaill upon 30 Rachrai (Rathlin Island, Northern Ireland) inhabitants, and upon some 300 inhabitants of Sheffield.

Breeding experiments on the fruit fly *Drosophila pseudo-obscura* are described by Prof. F. A. E. Crew and Rowena Lamy which indicate that the basis of mozaicism structure in these flies is some peculiarity following fertilization which permits of a division of the sperm nucleus before the fusion with the egg-nucleus becomes complete. As a result, part of the adult fly has a 'haploid' constitution (with only half the usual number of chromosomes in the cell-nucleus). The authors state that the presence of a chromosome complex capable of conjugation is not a necessary step in the process of maturation.

E. K. Janaki Ammal shows that hybrids obtained by crossing Java sugarcane (female) with bamboo show that only the offspring derived from parent cells containing the basic (haploid) number of chromosomes survive. In this they differ from *Saccharum* × *Sorghum* hybrids, which give viable hybrids also from diploid parent cells (containing twice the basic haploid number of chromosomes).

The occurrence of secondarily deposited calcium carbonate concretions in or below the surface soil in Berkshire (Upper Greensand and Calcareous Grit formations) is reported by Dr. F. F. Kay. Such concretions are typical of 'pedocals' (soils developed under dry climatic conditions) hitherto not reported from England.

perhaps, arising from the feelings of a section among the natives themselves.

Rattray, while still an officer in the Service, was one of the first to fly to West Africa; and on his retirement, flying divided his interest with anthropology. He became one of the pioneers of gliding. It was his ambition that the club which he founded at Oxford should eventually become a friendly rival of the similar club at Cambridge; but this ambition is now left for others.

WE regret to announce the following deaths:

Prof. A. E. Boycott, F.R.S., emeritus professor of pathology in the University of London, on May 12, aged sixty-one years.

Dr. W. Eagle Clarke, honorary supervisor of the Bird Collection and formerly keeper of the Natural History Department, Royal Scottish Museum, Edinburgh, on May 10, aged eighty-five years.

News and Views

Prof. Hans Geiger

THE Council of the Physical Society has this year awarded the fifteenth Duddell Medal to Prof. Hans Geiger, of the University of Tübingen. The medal is awarded to "persons who have contributed to the advancement of knowledge by the invention or design of scientific instruments, or by the discovery of materials used in their construction". Geiger's connexion with Great Britain goes back to the days, early in this century, when he went to Manchester to study radioactivity under the direction of Lord Rutherford, and it will also be remembered that one of the early results of this happy partnership was the demonstration of the possibility of detecting a single α-particle by its electrical effect. The method in its original form was somewhat tedious and troublesome, but the invention of the 'point' or Geiger counter made possible much more rapid counting, the counting of β- as well as of α-particles and, in its more recent form, introduced by Geiger himself, even the differentiation of the effects produced by α- and β-particles. These early researches and inventions laid the foundations on which have been built the more modern elaborate and less exacting automatic methods of counting used in this field.

GEIGER has also contributed notably to our knowledge of radioactive phenomena. In particular may be mentioned the experiments of Geiger and Nuttall, repeated later with greater accuracy by Geiger himself, to determine the ranges of the α-particles from various radioactive products. These experiments led to the formulation of the well-known rule connecting velocity and range, which gives a means of calculating velocities from known ranges with remarkable accuracy. But of outstanding importance are the experiments made in Manchester by Geiger and Marsden on the scattering of a beam of α-particles by thin sheets of matter. They recorded the striking observation that some of the α-particles in a beam directed on to a sheet of matter are deflected through very large angles and may even emerge on the side of incidence of the beam of α-rays. To explain the effect, Rutherford postulated the existence of large-angle scattering as the result of occasional single encounters with atoms. This led to the formulation of Rutherford's nuclear theory of atomic structure, with all its subsequent remarkable developments and far-reaching reactions on atomic theory.

Prof. E. Schrödinger and the University of Graz

SINCE the recent incorporation of Austria into Germany, little precise knowledge has been available as to the result of the change upon the position of some distinguished Austrian men of science. Upon inquiry we are informed that Prof. E. Schrödinger will continue to occupy the chair of theoretical physics in the University of Graz. The *Tagespost*, Graz, of March 30, publishes a letter from Prof. Schrödinger to the Senate of the University, in which he explains that he has not hitherto taken the active part expected of him in the National Socialist movement but is now glad to be reconciled to it. The last paragraph of his letter reads as follows: "Well-wishing friends who overestimate my importance consider it right that the repentant confession which I made to them should be made in public. I too belong to those who seize the outstretched hand of peace, because, sitting at my writing-desk, I have misjudged up to the last the real will and the true destiny of my land. I make this confession readily and joyfully. I believe it is spoken out of the hearts of many, and I hope in doing this to serve my country."

Dr. R. P. Linstead

DR. R. P. LINSTEAD, whose appointment to succeed Prof. G. M. Bennett in the chair of chemistry in the University of Sheffield, is announced on p. 943 is a distinguished younger worker in organic chemistry. Dr. Linstead is thirty-five years of age. He received his training at the City and Guilds College, Finsbury (1919–20), and at the Imperial College of Science and Technology, London (1920–25), graduating with first-class honours in chemistry in 1923. For a time he carried out research work in organic chemistry at the Imperial College, being awarded degree of Ph.D. (London) in 1926, and of D.Sc. (London) in 1929.

He received the Harrison Memorial Prize (awarded by the Chemical Society, the Institute of Chemistry, the Society of Chemical Industry and the Pharmaceutical Society) and the Meldola Medal (awarded by the Institute of Chemistry), both of which are given for research carried out by a worker less than thirty years of age. His main researches have been carried out in the field of organic chemistry, but have not been entirely confined to this field. He has published seventy-four original papers in the *Journal of the Chemical Society*, of which sixty-five are essentially on organic chemical topics. He is joint author with Prof. J. F. Thorpe of the seventh edition of Cain and Thorpe's "Synthetic Dyestuffs", and has written a number of articles for the "Dictionary of Applied Chemistry".

Mr. A. J. H. Edwards

MR. A. J. H. EDWARDS has been appointed director of the Scottish National Museum of Antiquities in succession to Dr. J. G. Callendar, who died on March 19. Mr. Edwards is the son of the late Capt. John Edwards of Dundee, one of the last of the well-known arctic whalers. He was educated at Robert Gordon's College, Aberdeen, and joined the staff of the Natural History Department of the Royal Scottish Museum in 1906. In 1912 he was appointed assistant keeper of the National Museum of Antiquities, and in 1913 went to Germany to study the preservation of antiquities with Prof. Rathgon, principal chemist to the German Government Museums. During the Great War he served in Malta, Salonika, Egypt and Palestine in the ranks and as an officer on the General List. He returned to the Museum of Antiquities in 1919 and also continued studies abroad. Mr. Edwards has visited the large museums in Norway, Sweden, Denmark and France and has contributed from time to time articles on archæological subjects which have been published in the *Proceedings of the Society of Antiquaries of Scotland* and other journals.

The Herbert Jackson Prize

THE London Midland and Scottish Railway announces that the first award of the Herbert Jackson Medal and Prize has been made to Mr. A. S. Davison, of the Crewe Chemical Laboratory, for a paper on the "Chemical and Biological Examination of Water Supplies". This medal has been struck by the Company in memory of the late Sir Herbert Jackson, and is to be awarded annually to a member of the Company's research staff for the best written account of an investigation carried out in the Company's laboratories during the year. Sir Herbert Jackson was an original member of the L.M.S. Advisory Committee on Scientific Research, on which he served from 1930 until his untimely death in 1936. He played an invaluable part in guiding the earlier work of the Committee, and above all, in encouraging the many members of the Company's scientific staff with whom he came into contact, and the directors felt that it would be appropriate to perpetuate his memory by the foundation of an annual prize for the encouragement of scientific research.

Sunspot, Magnetic Storm and Aurora on May 11

ON May 10·4 a large sunspot, crossing the sun's disk between May 4 and 17, reached the central meridian. The sunspot had originated on the sun's invisible hemisphere, and it seemed of possible significance that the longitude of the spot, 189°, differed little more than 10° from that of the large and spectroscopically active spot associated with the great magnetic storm of April 16 (NATURE, April 23, p. 721). On May 11 at $15^h\ 52^m$ U.T. a magnetic disturbance began, and this developed within a few hours into a "great" magnetic storm which, reaching a maximum towards 0^h (May 12), was accompanied by a display of the aurora borealis. At Greenwich the aurora was first seen by chance at $23^h\ 48^m$ U.T. by two of the astronomical observers, though from other reports it must have appeared some minutes before this time. The aurora, which was bright and of a deepish red colour, was described as having the form of a fan-shaped bundle of rays the apex of which extended to about 10° south of the zenith; at $0^h\ 10^m$ only faint streamers were visible. Since there was bright moonlight at the time, this aurora must have been intrinsically a very bright one, and doubtless other features would have been seen had the sky been dark. The records from the Greenwich magnetic station at Abinger, kindly communicated by the Astronomer Royal, give the following (provisional) ranges: in Declination, 80′; in Horizontal Force, 960 γ; and in Vertical Force, 420 γ. There was considerable ionospheric disturbance affecting long-distance short-wave radio transmission during the period of magnetic disturbance.

THIS magnetic storm, as pointed out by Greenwich, adds yet another member to a recognizable group of storms indicating a "magnetically" active region of the sun, extending over about 120° of longitude, which has been in operation since the beginning of 1937. If for each of the thirty-five magnetic storms recorded since then at Abinger, the longitude of the sun's central meridian at the time of the respective commencements be tabulated, it is found that in twenty-four cases (nearly 70 per cent) the solar longitudes lie between 60° and 180°; the remaining eleven storms are spread over the remaining 240° of longitude. It may also be noted that the seven "great" storms occurring during the last fifteen months correspond to solar longitudes 120° to 180°. Paradoxical though it may appear from the well-established statistical relationship between large sunspots and large magnetic storms, the distribution in longitude of large sunspots (in area greater than or equal to 500 millionths of the sun's hemisphere) over the epoch January 1937–May 1938 does not, however, favour these particular longitudes, but is more or less a random distribution. It is, of course, impossible to say how much longer this "magnetically" active region of the sun will continue to be associated with terrestrial magnetic storms, but the return of these longitudes to the sun's central meridian centred about June 8 will be observed with interest.

Discovery of a Near New Star

DR. OTTO STRUVE, Yerkes Observatory, reports the discovery of a new star to which the name Wolf 424 has been assigned. It is described as of the twelfth visual magnitude, and its spectrum is of the very late *M*-type. As is well known, it is possible to determine stellar distances to a fair degree of accuracy from their spectral type. The examination of the spectra of stars of known distances shows that the intensities of certain lines in their spectra vary with the true luminosity of the stars. Conversely, by studying lines in the spectra of stars, the real light output can be estimated, and this, combined with the star's apparent brightness, furnishes the necessary data for determining the distance. In the case of the new star, this method has been applied, and the spectroscopic parallax so found shows that it is probably closer to us than α Centauri. It should be pointed out, however, that there is considerable doubt about the true distance, for various reasons. Very great accuracy in determining the intensities of the lines is essential, and in addition, if, as is possible, the star is a very close unresolved binary, this would vitiate the results to some extent. There is no doubt about the star being fairly close to us, for which reason its trigonometrical parallax can be determined in about six months and its distance found by this independent method. Until this has been done, it is advisable to suspend judgment regarding Dr. Struve's conjecture that it may be the nearest star.

Recovery of Comet Gale (1927 vi)

MR. L. E. CUNNINGHAM, at Harvard, recovered this comet in the following position: 1938 May $1^d\ 5^h\ 51{\cdot}6^m$ U.T.; R.A. $17^h\ 23{\cdot}4^m$; S. Decl. 13° 4′; mag. 10. It is described as diffuse without central condensation or nucleus, and there is no report of a tail. Dr. A. C. D. Crommelin has deduced the following elements:

T	1938 June 18·47 U.T.	
ω	208·87°	1950·0
Ω	67·50	
i	11·62	
e	0·76085	
P	10·9966	

On May 18 the moon passed near the comet. As the object is moving rapidly southward it will be difficult for observers in the northern hemisphere to see it. The following ephemeris may prove useful for those who are favourably placed for observing it:

	R.A. 1950·0			S. Decl.		
1938 May	22·0	19^h	4^m	24° 41′		8·7
	30·0	19	55	30	6	8·4
June	7·0	20	53	34	46	8·2
	15·0	21	51	37	48	8·2

Dr. R. T. A. Innes has published a long paper on this comet and found a period of 4088·8 days. He predicted perihelion passage on 1938 August 24 and also a close approach to Jupiter in August 1917 (*Mem. Brit. Astro. Assoc.*, **30**, Fifth Report of the Comet Section). As the period is now known with considerable accuracy, it will be possible to examine the closeness of the approach to Jupiter in 1917.

The Evolution of Electrical Power

DR. A. P. M. FLEMING gave a Faraday lecture on "The Evolution of Electrical Power" to the Institution of Electrical Engineers on May 12. Applications of electrical power are to be found in every branch of our modern communal life, and yet few of those who make use of them have any real appreciation of the discoveries in which the modern system of electrical power had its origin, of the part which scientific research has played in making modern developments possible and of the direction in which new scientific discoveries may cause its continuous evolution to proceed. Few men have entered with success, comparable to Faraday's, into such a diversity of fields of investigation. We may well marvel that with only simple self-constructed apparatus available, he was able to formulate laws and lay down principles which have stood the test of time. Since Faraday invented the first electrical generator, numerous types of electrical generators have been developed; but the principle underlying them all is the same.

DR. FLEMING directed attention to the continuous increase in the voltages now used, to the change over from direct current to alternating current generation, to the increase in running speeds and to the enormous increase in the power output provided by single machines. These changes are linked with contemporary developments—to the introduction and improvement of the steam turbine prime mover, and to the rapid growth of central generating stations and their associated transmission and distribution networks. The electromagnetic method is not the only means of converting natural sources of energy into electrical form. The extent to which recent discoveries in the physical sciences, such as those of controlled atomic disintegration, cannot yet be forecast, but it is certain that much that is purely scientific to-day will form the basis of new industrial developments to-morrow. The spirit of Faraday is still at work, but now it works through many brains and with many hands so that who can say where it will lead?

Expedition to Greenland and the Canadian Arctic

IN his Friday evening discourse at the Royal Institution on May 13, Mr. J. M. Wordie described "An Expedition to North-West Greenland and the Canadian Arctic". The objects of the expedition were in part geological, in part archæological, but in the main to investigate cosmic ray intensity near the north geomagnetic pole by means of free floating balloons. The expedition sailed from Leith at the end of June, 1937. The cosmic ray observations were undertaken at various points in West and North-West Greenland, and six flights altogether were made. Two different types of apparatus were in use, one designed by Mr. E. G. Dymond which consisted of a triple-coincidence Geiger counter set with wireless transmission of the counts and the barometric pressure, the other constructed by Dr. H. Carmichael consisting of a miniature ionization chamber with electroscope and a small camera which photographed the latter

at work and at the same time recorded the temperature and atmospheric pressure. [Some of the results obtained are described by Mr. Dymond and Dr. Carmichael on p. 910 of this issue.] The greatest height reached from which a successful record was obtained was a little above 17 miles. In addition pilot balloons for testing the upper air currents were flown on twenty-eight occasions to heights in many cases of nearly 20 miles. From Thule in North-West Greenland the ship proceeded through Smith Sound to Kane Basin, and archæological investigations were made at a long abandoned Eskimo site at Buchanan Bay, Ellesmere Land, and continued in Jones Sound on North Devon Island. On the return journey the ship touched at North-East Baffin Land, which was found to be a region of long fjords which penetrate a glaciated mountain country south-westwards into hill country of low relief.

Exploring as a Career

As a rule the explorer has turned to that work as the result of chance. An adventurous spirit, often combined with financial resources, has been the introduction to exploration. Comparatively rarely, at least in Great Britain, has the explorer had the scientific training that is necessary for adequate results to be obtained from his work. A pamphlet issued by the Institute for Research, Chicago, entitled "Exploring as a Career" discusses at length the training, opportunities and possible scope of the prospective explorer. Much stress is rightly laid on personal qualities and accomplishments which an explorer should show. Though somewhat naïve in parts, the pamphlet on the whole covers the ground and incidentally directs attention to the great amount of work still awaiting true scientific investigation. A criticism that might be offered is that while a training in science is deemed essential, there is a tendency to advocate too superficial and general a course of study including even the study of public speaking, rather than a more intensive devotion to one or more branches of science which would equip the would-be explorer with the capacity to undertake specific investigations and devise new methods of research.

Native Africa and the Cinema

An interesting experiment in the instruction of the Bantu peoples in their tribal history and traditions has been undertaken, involving the co-operation of the administration and the people themselves. Major L. A. Notcutt, director of the Bantu Educational Cinema Experiment, has made a film dealing with the history, traditions and customs of the Wasamba, who live in the mountainous region behind Tanga in Tanganyika Territory. The members of the tribe, who took part in the film, it is stated in *The Times* of May 13, were directed by Mr. L. Vickers-Haviland, District Officer of the Wasamba tribe: while the tribal authorities agreed to contribute £40 towards expenses out of the amount the tribe receives for its treasury out of taxation for the pay of native courts, officials and other tribal expenses. The subject chosen by the members of the tribe themselves was the life of Mbega, a chief who lived some three hundred years ago, and was responsible for the foundation of the tribe as it exists to-day. The film shows his life in a series of major and minor incidents, beginning with the refusal of his father, an Arab, to allow him to be killed in accordance with the custom which prescribed that children who cut the upper teeth first, and consequently were believed to be evil, should be killed. Later incidents deal with his life as a hunter and wanderer, and the story closes with his consolidation of a number of tribes, of which he becomes the supreme chief. The natives, the producer states, took the greatest interest in ensuring accuracy of detail, and definitely elected for a film of an educational rather than a 'comic' character. The main work of the Bantu Experiment is to produce films of African life for educational purposes. It is promoted by the Department of Industrial and Social Research, and has received financial assistance from the Carnegie Trustees, the Union Government of South Africa and the Governments of the two Rhodesias.

Exhibition of Antiquities from British Honduras

A collection of antiquities from the Bay Islands, British Honduras, is on view at 10 Grosvenor Place, London, S.W.1, until May 31. The collection was formed by Lord Moyne during the summer of 1937, when a brief visit was paid to the islands and more than three thousand objects, mostly of stone and pottery, were obtained from sites known to the present inhabitants. Very few traces of burials or of skeletal material were found; nor was there any other evidence to suggest that the great majority of the specimens were of a funerary character. The shallow overlying soil showed no evidence of stratification. In a note on the collection, Mr. R. W. Feacham and Mr. H. J. Braunholtz (*Man*, May 1938) point out that the objects of stone and pottery exhibited show a remarkable range of development in form and design, and that the collection as a whole is, therefore, of the greatest interest, not only archæologically, but also from the point of view of the evolution of design. Some of the specimens have features typical of the Archaic pre-Aztec culture of the Valley of Mexico, while others have characteristics indicating a period of development extending from the end of the first millennium of our era to the close of the sixteenth century, not long before the original inhabitants were exterminated by Spanish colonists. Although the absence of stratification, and of evidence of the associations of different articles one with another, makes chronological sequence and cultural grouping uncertain, the size of the collection and the period of time covered makes it possible to verify and demonstrate the development of design convincingly by providing all the links in the chain without gap. Stylistically the evidence points to strong influence at various times from such widely separated regions as Panama, Costa Rica, Honduras and Mexico. The islands may have served as a trading station in pre-Columbian times, as the Pearl Islands did on the Pacific coast, whereby influences from various quarters would have been received and redistributed.

Accessions to the British Museum (Bloomsbury)

AMONG recent accessions to the collections of the British Museum (Bloomsbury), reported at the May meeting of the Trustees, is a notable addition to British antiquities. Mr. F. J. Durbin has presented to the Museum the collection of finds made some ten years ago by the late Mr. W. O. Klein when excavating the Romano-British temple at Worth, near Sandwich. It was then found that the Roman temple, built of stone and erected in the second half of the first century A.D., was situated on the site of a prehistoric British shrine of Early Iron Age date, not less than one, and probably four or five centuries earlier. Among the finds were British and Roman brooches, bronze votive offerings in the form of shields, iron and bone implements in large numbers, and a considerable quantity of pottery, ranging from the Iron Age to the Roman occupation. Among antiquities from the East reported at the same time were a fantastic bronze animal figure from Iraq of the older Babylonian period (about 2000 B.C.), and a painted terra-cotta figure of a horseman, which is said to come from Luristan in Persia, and in date is thought to fall between the eighth and fourth centuries B.C. Archæologists who are concerned with western Asia will also be interested in the announcement that a diary kept by Gertrude Lowthian Bell, apparently in Arabia in 1911, has been presented to the Department of Manuscripts by her sister, Lady Richmond. The bequest to the Museum by the late Mr. T. W. Gann of jade objects, pottery and other antiquities from Central America, acquired in the course of his journeys of exploration, has now been received. The jade objects, in accordance with his desire, will be kept together as a unitary collection.

Film Demonstration of Money Movements

IN view of the recent discussions on "Science and Society" in our columns, many readers will be interested to learn that Prof. M. Polanyi, professor of physical chemistry in the University of Manchester, has produced a short film entitled "An Outline of the Working of Money". The film, which runs for 25 minutes and, except in the opening section, is in diagrammatic form, is divided into five parts. It deals in turn with the circular flow of money, the actions of saving and spending, the functions of the banks, depreciation and the role of the capital goods industries, and finally the interaction of these forces affecting the working of the economic system. In the preparation of the film, simplification of ideas has of course been necessary, but it presents a most interesting venture—so far as we are aware, the first venture—in the application of methods of visual presentation to economic theory. The film was first shown to members of the Manchester Statistical Society in March, and the Society has now published the full script of the film. The film itself, which is at present only available in a silent version, was made by Science Films Limited.

A Psycho-Technical Laboratory

IN *The Engineer* of May 13 is an illustrated account of the new Psycho-Technical Laboratory recently erected at Viroflay, near Versailles, for testing candidates for employment on the French State Railways. The laboratory, which is under the direction of Prof. Laugier and his assistant Mlle. Weinberg, is stated to be the most complete of its kind in France. The equipment includes two machines for neuro-muscular tests, an electro-cardiograph, an apparatus for vigilant attention tests, a sound-proof cabin for hearing tests, and an apparatus for testing the candidate's response to visual signals. The room in which the electro-cardiograph is installed is completely darkened. The heartbeats of the candidate having been recorded on a moving band of photographic paper, a powerful light is flashed into the candidate's eyes and a loud and raucous motor-horn sounded, the test being designed to determine the heart's reaction to these sudden stimuli. Tests have been carried out for some years under temporary conditions, but they were not regarded seriously by the railway administration. It being observed that candidates rejected by Prof. Laugier prove less efficient and more prone to accident, has, however, led to the erection of the laboratory.

The Institution of Electrical Engineers

THE report presented at the annual general meeting on May 12 to the Institution of Electrical Engineers, shows that it is in a very flourishing condition. The membership has increased from 13,561 to 18,252 during the last ten years. The use of the Institution's premises has been granted, without charge, to a number of kindred societies in connexion with their meetings and 188 such meetings have been held during the past year. It has been arranged that as soon as a member of any class has completed fifty years of membership he will automatically cease to be asked any further subscriptions. The Council has decided that facilities to attend Institution meetings and to use the reference library should, as a gesture of good will, be offered to Chinese electrical engineering apprentices and students who, under arrangements made by the Federation of British Industries, have been given opportunities for engineering experience in Great Britain with the object of improving and fostering relations with China. The Council is also giving more active support to the Engineer's 'German Circle'. The lectures given by this Circle are in German and are by eminent German-speaking engineers. On each occasion, they will be followed by a short discussion in German. Those present can thus further their knowledge of technical German.

THE following award of premiums for papers read during the session 1937–38, or accepted for publication have been awarded by the Institution of Electrical Engineers: Institution Premium to A. D. Blumlein, C. O. Browne, N. E. Davis and E. Green; Ayrton Premium to the late H. W. Clothier and B. H. Leeson and H. Leyburn; Fahie Premium to F. G. Tyack; John Hopkinson Premium to Dr. W. G. Thompson; Paris Exhibition (1881) Premium to J. S. Pickles; Overseas Premiums to Dr. V. K. Zworykin, Dr. G. A. Morton and L. E. Flory; and

to Prof. B. L. Goodlet; Extra Premiums to E. T. Norris, D. J. Bolton, A. H. Davis, O. W. Humphreys, C. E. Fairburn, W. Maurice, J. N. Waite; Wireless Section Premiums to T. C. Macnamara and D. C. Birkinshaw; J. Bell, J. W. Davies and B. S. Gossling; A. J. Gill and Dr. S. Whitehead; Meter and Instrument Section Premiums to K. J. R. Wilkinson, T. A. Ledward, C. W. Hughes; Transmission Section Premiums to Dr. J. L. Miller and Dr. J. M. Thomson (Sebastian de Ferranti Premium), Dr. S. Whitehead and Mr. E. E. Hutchings.

Centralized Control of Public Lighting

IN a paper read to the Institution of Electrical Engineers on May 11 by H. Purslove Barker, a full account is given of the new methods of the centralized control of public lighting and off-peak loads, by superimposed ripples. Although clock-switches have to-day reached a high pitch of mechanical perfection, they are only suitable for services where the switching routine is prearranged and invariable. There are very few applications of this kind of switching where the time of the day is the only element which should regulate the operation of a switch. For example, in street lighting the correct time to switch on and off may be determined by the incidence of fog, war or other emergency. By the aid of a central transmitter it is now possible to transmit signals by ripples of current in the distributing and feeding mains, so that one signal acting on a relay turns street lights on, another controls off-peak loads and so on. The system can operate, from a central position, an unlimited number of inexpensive relays. It appears probable that in many areas very restricted lighting will be permitted during war-time, provided that it can be instantaneously extinguished. A centralized ripple control system is now used in Paris for operating warning syrens over a large area. The same ripple that is used to start warning syrens can also be employed to call air-raid wardens in their homes by the aid of a portable relay comprising a bell which can be plugged into any socket in the network. This system of control may prove useful for many purposes in the future.

Recommendations for Seed Potatoes

POTATO growers when considering the purchase of seed for next year's planting should obtain the leaflet on seed potatoes which the National Institute of Agricultural Botany, Cambridge, issues free of charge. Despite the encouragement given to potato breeding by the Ministry of Agriculture, and Scottish and Irish Departments of Agriculture for many years, more than 90 per cent of the potato acreage in Great Britain is still planted with varieties which have been on the market for more than twenty years. In most cases, newer varieties could be introduced with considerable benefit, and it is suggested that growers who are naturally reluctant to discard varieties with which they are familiar should at least try small quantities of the newer kinds so that they can test for themselves the value of the recommendations made. In the first-early class, Arran Pilot and Doon Early are suggested, while Gladstone, Redskin and Arran Signet are the recommendations for second-early or main crop potatoes. For late main crop, Dunbar Standard and Arran Cairn both produce white kidney tubers of excellent quality. A number of the older varieties are susceptible to wart disease and possess such faults as poor shape, indifferent cooking quality and proneness to second growth, but these new varieties are immune from wart disease and are only recommended after careful trial. The certificates issued by the Ministry of Agriculture and Scottish and Irish Departments of Agriculture for growing crops of potatoes, are a reliable guide to the standard of health of the purchased seed, and growers should become familiar with the different grades, that they may understand the nature of the guarantee supplied.

Commonwealth Fund Fellowships Awards

THE Committee of Award of the Commonwealth Fund fellowships has made the following appointments, among others, to fellowships tenable by British graduates in American universities for the two years beginning September 1938. These fellowships are offered by the Commonwealth Fund of New York, of which Mr. Edward S. Harkness is president: Dr. G. H. Benham, University College, London, to the University of Wisconsin, in biochemistry; Dr. Bernard Cannon, University of Liverpool, to Princeton University in mathematics; A. G. Cowan, University of Glasgow, to Brookings Institution, Washington, in economics; M. W. H. Davies, University College of North Wales, Bangor, to the Massachusetts Institute of Technology, in engineering; K. J. Laidler, Trinity College, Oxford, to Princeton University, in chemistry; E. H. Lee, Gonville and Caius College, Cambridge, to Stanford University, in engineering; M. W. Lister, Oriel College, Oxford, to Harvard University, in chemistry; J. M. Meek, University of Liverpool, to the University of California, in engineering; H. B. Parry, Queens' College, Cambridge, University of Edinburgh, and Royal Veterinary College, London, to the University of Wisconsin, in veterinary science; E. R. Roberts, Imperial College of Science and Technology, London, to the University of Minnesota, in agriculture; H. B. Whittington, University of Birmingham, to Yale University, in geology; P. V. Youle, University of Sheffield, to the University of California, in physical chemistry.

THE following have been appointed to fellowships tenable by candidates from the British Dominions: A. M. Acock, University of Cape Town, and Brasenose College, Oxford, to the University of California, in botany; J. S. de Wet, University of Cape Town, Balliol College, Oxford, and St. John's College, Cambridge, to the Institute for Advanced Study, Princeton, in mathematics. The following have been appointed to fellowships tenable by candidates holding appointments in Government service overseas: J. G. Crawford, University of Sydney, of the Rural Bank of New South Wales, Government of New South Wales, to Brookings Institution and Government agencies, Washington, D.C., in economics;

F. G. Forman, University of Western Australia, of the Department of Mines, Government of Western Australia, to Harvard University, in geology; L. A. Hurst, University of Cape Town, of the Department of the Interior, Government of South Africa, to the New York State Psychiatric Institute, in medicine; C. S. Plank, University of New Zealand, of the Post and Telegraph Department, Government of New Zealand, to the American Telephone and Telegraph Company, and associated companies, in engineering; Dr. V. A. Wager, Transvaal University College, and University of the Witwatersrand, of the Department of Agriculture, Government of South Africa, to the University of California, in agriculture. The following have been appointed to fellowships tenable by candidates holding appointments in the Home civil service: A. B. Cohen, Trinity College, Cambridge, of the Colonial Office; H. G. Gee, University College, and London School of Economics, University of London, of the Ministry of Labour; Robert Macdonald, University of Glasgow and Lincoln College, Oxford, of the Scottish Education Department.

Announcements

At the general monthly meeting on May 9, Prof. W. L. Bragg was elected professor of natural philosophy in the Royal Institution, in succession to the late Lord Rutherford. Prof. Bragg, who is the son of Sir William Bragg, the Fullerian professor of chemistry and director of the Royal Institution, was recently appointed Cavendish professor of experimental physics in the University of Cambridge. He is thus the fourth Cavendish professor, following Lord Rayleigh, Sir Joseph Thomson and Lord Rutherford, who has also held the London professorship. At the same meeting Sir J. J. Thomson was re-elected honorary professor of natural philosophy and Sir James Jeans was re-elected professor of astronomy.

Prof. F. Verzár, professor of physiology in the University of Basel, will deliver a series of lectures on absorption in the intestine and the physiology of the adrenal cortex in the University of Oxford (Physiology Theatre, University Museum) on May 23, 24, 27, 30 and 31. Further information can be obtained from Prof. J. H. Burn, Department of Pharmacology, Oxford.

The following appointments and promotions have recently been made in the Colonial Service: G. H. Addison, assistant curator of gardens, Straits Settlements; A. G. Bailey (agricultural officer), education officer, Kenya; R. M. Gambles (veterinary officer, Cyprus), veterinary research officer, Palestine.

At the annual general meeting of the Institution of Civil Engineers held on May 10, Mr. W. J. E. Binnie was elected president for 1938–39 and will succeed Mr. S. B. Donkin on November 1. On the report of the judges (the president of the Institution of Civil Engineers and the president of the Royal Institute of British Architects), the Council has awarded a Charles Hawksley Prize of the value of £150 to Mr. Louis Matheson for his design of a multi-storied public garage.

The *Renaissance Française* has opened a subscription for a bust of the late Dr. Emile Roux by the sculptor Armand Bloch, to be presented to the Pasteur Institute of Paris of which Roux was director for many years.

The eighth international congress for occupational diseases and accidents will be held at Frankfort-on-Main on September 26–30. Further information can be obtained from Ministerialrat Dr. Bauer, Unter den Linden 13, Berlin, 8.

The fourth annual congress of medical electro-radiologists will be held in the physics amphitheatre of the Paris Faculty of Medicine on October 5–8, under the presidency of Dr. Delherm. The chief subject for discussion will be neutrons and artificial radio-elements—their biological applications and therapeutic possibilities. Further information can be obtained from Dr. Morel-Kahn, 45 rue Scheffer, Paris.

The first two volumes of Pavlov's works will be published by the Soviet Government this year in Russian, English, French and German. The first volume will contain his articles and speeches on social and political subjects and his works on circulation of the blood, and the second his observations on the physiology of digestion.

According to statistics recently published by the Health Department of Palestine for 1936, the estimated population of Palestine at the end of June, 1936, was 1,269,952, of whom 781,789 were Arabs, 370,471 Jews and 106,473 Christians. The birth-rate was 53·14 per 1,000 among Mohammedans, 36·34 among Christians and 29 among Jews. The death-rate was 19·98 per 1,000 among Mohammedans, 12·63 among Christians and 8·83 among Jews.

Vol. 22 (1938) of the *Comptes Rendus* of the Carlsberg Laboratory is a jubilee volume in honour of the seventieth birthday of Prof. Sørensen, a portrait of whom is prefixed to it. Many papers (occupying in all 570 pages) by several well-known authorities cover a wide range of subjects, mostly of biochemical interest.

We have received from Messrs. Newton and Co., 72 Wigmore Street, W.1, their catalogue of the "Newton and Wigmore" British epidiascopes. Several types are listed, including inexpensive models for school use. The Newton projection microscope is another product supplied by the firm, the outfit ordinarily supplied being suitable for a $\frac{1}{2}$in. objective. Messrs. Newton are also agents for the "Ampro" 16 mm. cinematograph projector, of which both sound and silent equipments are supplied.

Research Items

Classification of the Races of China

MR. CHUNGSEE H. LIU has attempted a classification of the races of China (*Zs. f. Rassenkunde*, 6, 2; 1937) in which he points out that the Chinese people are by no means a homogeneous unit as commonly supposed and examines critically the classifications of those anthropologists who have recognized this fact. Mongol, Mongoloid and Mongolian, are loose and unsatisfactory terms, and *Homo sinicus* is suggested to replace them. In the Chinese population as a whole, the physical characters are, in general terms: hair universally black, lank or coarse, straight, with almost circular cross-section; body and face hair very scanty; skin varying from yellowish to yellow-brown; eye colour light-brown; setting of eyes horizontal or oblique with epicanthic fold; cheek bones prominent, mesocephalic on the brachycephalic side; nose relatively flat with depressed nasal bones; mesorrhine; medium stature; slender or thick-set, hands and feet small. Within this general description, three types are recognized, which are distributed in accordance with the three great river-systems of China: (1) The Huangho type in the north, mainly found in the valley of the Huangho, the Liao Ho, and the Sungari River in Manchuria. This type is of high stature, dolichocephalic, leptorrhine, and of vigorous physique and robust feature. It is honest and frugal, slow but sure, chivalrous and conservative. The people speak the northern Chinese mandarin, and may be regarded as the archaic type of Chinese. (2) The Changkiang type, mostly confined to the Chang Kiang or Yangtze River valley in a favourable natural environment. This type is of medium stature, mesocephalic, mesorrhine, with light yellowish complexion. The people exhibit great literary power and ability. They speak southern Chinese mandarin with local dialects—the progressive type of the Chinese nation. (3) The Chukiang type in the Chu Kiang or Pearl River valley of southern China, with Fukien as an eastern corridor and Hainan Island beyond the sea. They are of shorter stature, brachycephalic, platyrrhine, of darker skin colour. Mentally this type is vivacious, and adventurous, quick in action and radical in thought. They speak various dialects of southern China.

Skeletal and other Remains from the Virgin Islands

REMAINS, skeletal and other, of the early inhabitants of the Virgin Islands, which had been discovered on Water Island, near St. Thomas, by Mr. A. H. Julien, were collected by Mr. J. S. Trevor in 1936. Burials of about twenty-one persons lay 2–3 ft. below the surface, in direct association with shells of the giant conch (*Strombus gigas*) and other gasteropods, small animal bones, probably those of the Indian coney (*Capromys brachyurus*), lumps of a red ochreous substance, stone implements and pottery. The skeletal remains are discussed by Dr. L. H. Dudley Buxton and the pottery by Prof. Gudmund Hatt of Copenhagen in *Man* of April 1938. As the skeletons had been reinterred, it was impossible to locate more than seven, but the occipital bone of an eighth individual was also found. These are represented by skulls, mostly incomplete, humeri, pelvic fragments, sacra, femora and calcanea, which are now in the Oxford collection. Measurements have been made by Dr. Buxton, who regards the material as too scanty to give anything but the most tentative results. In 1492, Dr. Charlotte Gower has concluded, there were at least three populations in the West Indies, possessing distinct cultures. These were the Caribs, the Ciboney and the Tains and/or Ygneri. Owing to the lack of any description of the physical characters of the aborigines for comparison, the present material admits of the addition of nothing substantial in the way of argument from the skulls. None of them displays artificial deformation, which is common in the Carib, but is said to be absent in the Ciboney. There is no high cephalic index, though the general tendency of the West Indian skulls is towards brachycephaly. High nasal indices and marked prognathism suggest negroid characteristics, but a secondary interment after the introduction of negro slaves seems unlikely. In his discussion of the pottery, Prof. Hatt affirms that the vessels are of pre-Columbian Indian origin. In form and ornament, the pottery resembles that found previously in St. Thomas and St. Croix. It is probably earlier than the Carib invasion and, therefore, Ignerian, that is, Arawak.

Vascular Anatomy as a Taxonomic Tool

THIS subject has received a very thorough treatment by P. A. Vestal (*Phil. J. Sci.*, 64, No. 3, November 1937) in connexion with the Hypericaceæ and Guttiferæ and allied families. The vascular characters that proved most significant were the dimensions of the vessels, the nature of their perforations and of the pittings upon their walls, the pitting and dimensions of fibre tracheids and the characters of the rays, particularly the uni-seriate rays. It is concluded that the groups studied fit very well with the taxonomic groups of Wettstein, the Parietales and Guttiferales, and that the anatomical evidence is more in favour of this author's treatment of these families or of their arrangement by Engler and Prantl than with their treatment by Hutchinson. The anatomical criteria found of value in this study agree very well with those of which the significance is underlined in a more general study of the same problem by L. Chalk (*Ann. Bot.*, N.S., 1, 409–428), but the latter author finds Hutchinson's arrangement of the Archichlamydeæ more in agreement with the evidence from anatomy than that of Engler.

Effects of Radiation on Polypore Fungi

THE results of a detailed investigation into the action of ultra-violet rays, X-rays, radium and sunlight upon three polypore fungi, formed the subject of the presidential address by Prof. S. R. Bose to the Botanical Society of India on January 6, 1938 (*J. Ind. Bot. Soc.*, 17, No. 1, 5; 1938). *Polyporus ostreiformis*, *Polystictus leoninus* and *Trametes cingulata* were the three species concerned, and the experiments were made with plate cultures upon malt extract agar. Ultra-violet rays and excessive direct sunlight diminished for a time the fertility of all three fungi, and in some cases even death ensued. Both hard and soft X-rays were studied; small doses

gave slight injury, from which the organisms recovered quickly, whilst heavy doses totally suppressed sporophore formation. Conidia and chlamydospores, however, remained almost unaffected. No effect of X-rays in promoting saltations, or mutations in culture, was observed. Treatment of the three polypores with large doses of radium damaged the vegetative hyphæ and delayed the formation of fruit bodies, but subcultures recovered quickly. It is a notable fact that the three species mentioned will not fruit in darkness, so evidently they can tolerate, if not enjoy, the amounts of radiation present under natural conditions.

Action of Ammonia on Mercurous Chloride

ALTHOUGH the blackening resulting from the action of ammonia on mercurous chloride is now usually regarded as due to finely divided mercury, the nature of the other product has been the subject of discussion. H. R. Frecke and M. C. Sneed (*J. Amer. Chem. Soc.*, **60**, 518; 1938) have shown that the course of the reaction is influenced by the concentration of aqueous ammonia (ammonium hydroxide) used, as well as by the time of reaction. The end-products with concentrated ammonia are a grey precipitate of the composition ($Hg + NH_2.HgCl$) and the water-soluble fusible compound $HgCl_2.2NH_3$. The latter on dilution partially decomposes into NH_2HgCl and ammonium chloride: $HgCl_2.2NH_3 \rightleftharpoons NH_2HgCl + NH_4Cl$, so that the total reaction would be: $Hg_2Cl_2 + 2NH_4OH = Hg + NH_2HgCl + NH_4Cl + 2H_2O$. In the case of dilute ammonium hydroxide, however, the speed of reaction is sufficiently slow to permit the identification of the intermediate products, namely, mercurous oxide (Hg_2O)—which does not amalgamate gold sheet—and ammonium chloride, which further react to produce metallic mercury and NH_2HgCl: $Hg_2O + NH_4Cl = NH_2HgCl + Hg + H_2O$. The authors consider that under ordinary conditions the reaction between mercurous chloride and ammonium hydroxide is best represented by the equation: $2Hg_2Cl_2 + 4NH_4OH = [Hg + Hg_2O + NH_2HgCl] + 3NH_4Cl + 3H_2O$.

Theory of Liquids

IN a series of papers published in Indian journals between 1934 and 1936 a theory of liquids was developed by Dr. T. S. Wheeler, who obtained formulæ for many liquid properties, such as surface tension, viscosity and heat of evaporation, in terms of interatomic forces of the Lennard-Jones type. A collected account of this work has now been published (*Trans. Nat. Inst. Sci. India*, **1**, 333; 1938). The theory is based on simple physical ideas and uses only elementary mathematics. A liquid is regarded as composed of a number of force centres, each of which vibrates within a spherical space kept free from other molecules by its thermal motion, and the translational motion is assumed to be small compared with the vibrational motion. A number of formulæ have been derived relating certain properties of a liquid with one another, and when the Lennard-Jones force constants are substituted in them they give numerical results in fair agreement with experimental values. The method employs a number of simplifying assumptions such that the molecules of a liquid are uniformly distributed round any one, that within the free spherical volume in which each molecule moves there is no field of force, and that the formulæ of the kinetic theory of gases may be applied. There is no discussion of entropy or of free energy, on which alone calculations of vapour pressures can rigorously be based. None the less the paper gives a picture of a liquid which, while oversimplified, may help some workers on this subject to visualize liquid properties more easily.

Principles of Plant Design in Electrolysis

IN a paper on electrolysis discussed at a joint meeting of the Institutions of Electrical and Chemical Engineers on April 27, Dr. H. J. T. Ellingham concludes that although the principles on which the design and operation of plant for electrolysis depend are at least as simple and clear-cut as those for most other kinds of industrial process, their successful application requires close co-operation between the chemical engineer and the electrical engineer. This would ensure the co-ordination of the electrical and chemical factors in any particular problem in the most complete and appropriate manner. The paper sets out and correlates the relative electrochemical principles. Electrolytic processes may be carried out in order to obtain products such as metals, alkalis, oxygen and hydrogen, and various salts, which are to be marketed as such; but certain of these processes may also be worked as part of some other industry, as, for example, electroplating in the motor-car industry, alkali and chlorine in the manufacture of paper, and chlorates in the match industry. For many processes, electrolytic cells of various types have been patented, and units of standard size and output can be purchased from the respective manufacturers, for example, cells for the production of oxygen and hydrogen, or alkali and chlorine, and plant and chemicals for electroplating. Some electrolytic processes depend for their efficient operation on continuous working during day and night. These provide a very steady and continuous load for a power station. Many types of electrolytic operation are worked intermittently and a few, like oxygen and hydrogen, can be operated for irregular periods without much loss of efficiency. It would be advisable to arrange that these loads should be operated during 'off-peak' loads in conjunction with other intermittent electrical processes, so as to effect economies for both the chemical and electrical industries by securing a high load factor.

Spectrohelioscope with a Vibrating Slit Mechanism

MR. F. J. SELLERS, director of the Solar Section, British Astronomical Association, has described his own construction of a spectrohelioscope, involving certain departures from the standard type (*J. Brit. Astro. Assoc.*, **48**, 6; April 1938). Mr. Sellers considered that oscillating slits would be more satisfactory than rotating prisms, and the spring-vibrating system is very simply operated by means of an electric contact-breaker, like an electric bell. The optical reversal occasioned by the collimating mirrors necessitates that the second slit should move in opposite phase to the first and remain parallel to it. A full description with a diagram is given of the various parts. Any amateur would be able to construct the various fittings required for the apparatus. It is interesting to notice that ordinary bell-battery dry cells operate the contact-breaker, and that these have been in use for eighteen months without serious signs of depreciation. Indeed, the whole apparatus has not given a moment's trouble since it was first tried in October 1936.

Roman Britain

RECENT study of Roman Britain has profited on the whole more perhaps than any other branch of archæological research in Great Britain by co-operation between the national administrative body, the Office of Works, with its statutory powers, the local authority, and the local archæological society, representing expert knowledge and instructed interest. A conspicuous example of the success of such co-operation is afforded by the excavation of the Forum of Roman Leicester, of which a part, the so-called Old Jewry Wall, was handed over to the custody of the Office of Works so long ago as 1920, but of which it became possible to ascertain the true character only after the site had been acquired by the Corporation in 1935 for public baths. Thanks to an enlightened, but economical, solution of the financial problem on the part of the authority, public and private funds were able to combine to carry out a thorough examination of the site in 1936 and 1937 under the direction of Miss Kathleen Kenyon, with the result that by a further public-spirited act on the part of the Corporation, Leicester now possesses one of the most striking and remarkable monuments of Roman Britain still surviving.

The character and history of the complex of which the Old Jewry Wall had been the only visible relic since the Middle Ages, though not completely revealed, especially in regard to some of the more interesting features, until the excavations of 1937, was apparent in the more important essentials when the work of 1936 was brought to a close. An account of the results of the first season's work has been published by Miss Kenyon recently (*Trans. Leicester Lit. Phil. Soc.*, 1936–37).

The earliest inhabitants of the portion of the site excavated in 1936 would appear to have been slightly Romanized Celts of the Belgic tribes; but as none of the pottery then found dated from before A.D. 40, it seemed likely that they had been attracted, whence is not known, by the legionary camp established here on the line of the Roman advance. In the following period, a town was laid out on Roman lines, some of the roads constructed passing over the pits of the first occupants. For the next fifty years or so, the houses along this road were built of wood with clay-filled walls and mainly occupied by the descendants of the original tribesmen. They were becoming gradually more Romanized. Then about A.D. 120 Leicester shared in the movement for setting up grandiose municipal buildings over Roman Britain. The area was cleared and the whole laid out as a basilica and forum in the usual Roman style and on a scale which compares with any in Britain. Though the later history is obscure, the site was undoubtedly occupied in the third and fourth centuries; but towards the close of the period, the neglected state of the roads points to the time when municipal organization was breaking down and trade and other civilized activities were failing. Thereafter, more especially with the Saxon occupation, the buildings served merely as quarries, the incorporation of the wall, which survived to modern times, in an early Saxon church probably being responsible for its preservation.

A further example of the valuable results which may accrue from such co-operation between public authorities and private bodies is afforded by recent work of the Letchworth Natural History and Antiquarian Society, for a report of which we are indebted to Mr. W. Percival Westell, honorary curator of the Letchworth Museum. The Hitchin Rural District Council in carrying out a housing scheme proposed to erect cottages partly on the site of the outer bailey of Great Wymondley Castle, near Hitchin. The scheme was approved by the Office of Works, provided that it were carried out under expert archæological supervision. This supervision was undertaken at the request of the Office of Works by the Letchworth Society. Unfortunately a drainage trench, which had yielded Romano-British pottery, had already been filled in before representatives of the Society arrived, nor could it be reopened; but a series of trenches was opened as near the line as possible. From these much interesting material was obtained. A large number of bases and sherds of Romano-British pottery was found, together with bones and teeth, tiles, nails and oyster shells. In one trench at a depth of 1 ft. 6 in. there was discovered a flint and rubble floor, measuring six feet in width and twenty-four feet in length, while at the south-west corner was a rubbish pit. An extension of the floor, but with much smaller flints, was found at right angles and at a depth of 2 ft. 6 in. This was 1 ft. 6 in. below the old turf level, which was plainly visible at a depth of 1 ft. below the present surface. In another trench was a circular layer of flints, within which was a rammed floor. This was without flints, and overlying it were many pieces of fired daub and cut pieces of wattle of elm wood. This would appear to be the site of a primitive oval thatched hut, probably for storage, and, it may be, pre-Roman. No pottery or other objects were found within the circle. The diameter of the circle of flints is 8 ft. The pottery found is of the first and second centuries A.D. and consists of coarse ware cooking pots, grey ware bowls, dishes and vases, and black ware. A few fragments only of Samian ware were found.

The activities of the Society in other parts of Hertfordshire have produced some interesting finds. At Baldock, an exceptionally rich region, two full-length skeletons, a quantity of pottery and building materials, as well as parts of British and Roman querns have been found. From South Road came a perfect large coarse ware brown urn, containing a heavy cremation with a Samian dish clamped at the side. This rested on the skeleton of a horse, and was found at a depth of three feet. A number of Romano-British finds are also recorded from Ashwell, Hitchin and Letchworth itself. The last named, the remains of four Romano-British pottery vessels, indicate that the rectangular pit-dwellings, such as recently were recorded at Hawthorn Hill, Letchworth, extended still farther to the north-west.

The excavation of the hill-fort known as The Caburn, near Lewes, which was described by Dr. A. E. Wilson before the Society of Antiquaries of London on February 10, was especially interesting for the evidence which it furnished of successive

occupations. Pottery found in the old turf beneath the early rampart pointed to an occupation of an undefended village settlement dating at about 500 B.C. Then at about 250 B.C. the top of the hill was enclosed by a single rampart and ditch which are still visible as an inner work. At about 50 B.C. an extensive and ambitious scheme of refortification was undertaken, which included an outer rampart and ditch. This, however, seems not to have been completed. A complete rebuilding took place in the year, approximately, A.D. 50, when a full outer rampart and ditch were constructed. The site was then neglected for a thousand years, until in the eleventh century some refortification took place. The excavations have been carried out by Dr. Wilson on behalf of the Brighton and Hove Archæological Society, with the assistance of Dr. Cecil Curwen and Mr. G. P. Burstow.

An account with photographs of the recently discovered western postern for pedestrians of the Newport Arch at Lincoln is given by Mr. F. T. Baker in *Discovery* of February. This arch, famous for having been in uninterrupted use since its erection probably in the second century A.D., was the northern gateway of the Roman occupation. The surviving portion consists of the southern face of the main arch and an eastern postern; but the demolition last autumn of a building abutting on the western side of the arch brought to light the spring of an arch, which confirmed previous conjecture that there had also been a postern for pedestrians on the western side. It is evident that barrack rooms, or chambers for some such purpose surmounted the arch. The discovery of a portion of the Roman city wall in the course of the work indicates that this met the structure of the gate at approximately the centre, and not flush with the south or north face as previously thought. The exterior angle, possibly, may have been filled by a bastion.

The Rockefeller Foundation*

Barriers to International Aims

FROM the beginning of its activities twenty-five years ago the Rockefeller Foundation has been guided by the objective written into its charter: "The well-being of mankind *throughout the world*". In accordance with this purpose the aim of the trustees has been to maintain the work of the Foundation on an international plane without consideration of flags or political doctrines or creeds or sects. Particularly in a programme based on the advancement of knowledge it is imperative to disregard the geographical boundaries which arbitrarily and often unhappily divide the earth into a patchwork of senseless antagonisms. For in the last analysis knowledge cannot be nationalized. No successful embargoes can be maintained against the export or import of ideas. Whether new conceptions in atomic physics come from Copenhagen or from Cambridge, England; whether the cure for cancer is developed in New Haven or in Berlin; whether it is a Russian or an Italian or an American who takes the next step forward in mankind's struggle with virus diseases—we are all of us, under whatever flag, the joint beneficiaries of the intellectual property of the race. In all the clash of competing nationalisms there is here an underlying principle of unity: the single aim and language of science in the discovery of truth. It is this principle which challenges the twentieth century with the conception of civilization as a co-operative achievement and with the ideal of intellectual capital as an international possession.

A foundation, therefore, whose aim is to assist in pushing out the boundaries of knowledge must necessarily work wherever the best tools are to be found. In its search for high talent and promising opportunities it must assume that frontiers are not the forbidding barriers they pretend to be.

This ideal, which for more than two decades the Rockefeller Foundation has consistently attempted to follow, has in recent years encountered serious difficulties. And these difficulties are increasing. Objective scholarship is possible only where thought is free—and freedom can exist only where there is tolerance, only where there are no "Keep Out" signs against the inquisitive and questioning mind. Disinterested research cannot survive in an atmosphere of compulsion and repression. It withers under the efforts of Governments to impose uniform ideologies and to circumscribe in the interests of a dominant regime the area of intellectual liberty. Particularly in the broad range of subjects covered by the social sciences, and in the humanities as well, the world has recently witnessed in several countries the progressive disintegration of creative scholarship.

This phenomenon has naturally affected the programme of the Foundation. In some fields it is now profitless to go where we formerly went. We find ourselves stopped at some frontiers—not because the frontiers have any greater geographical significance than they had a few years ago, but because behind them the search for truth by eager and sceptical minds has been made impossible.

Some twenty years ago in a Central American city a revolution developed while the Foundation was engaged in a study of yellow fever control measures. Dr. Emmett Vaughn, who was in charge of the work, determined to continue his research. Every morning with a flag of truce he crawled through the barricades to collect his mosquitos on one side of the fighting line, and in the afternoon he crawled back again to gather up his specimens on the other side. He was molested by neither army. Both sides thought him somewhat crazy—a man who, when great issues of human destiny were being fought out, spent his time catching mosquitos. To-day in that Central American country the revolution has been largely forgotten, but Dr. Vaughn is remembered as the man who helped to stamp out an age-long pestilence.

The Rockefeller Foundations likes to think of this incident as an example of what its approach to the welfare of mankind should be. But occasionally aggressive action by the fighting lines makes impossible even the gathering of mosquitos!

* From the Rockefeller Foundation: A Review for 1937. By Raymond B. Fosdick, President of the Foundation. (New York, 1938.)

Alchemy under James IV of Scotland *

JAMES IV of Scotland was one of the most intelligent princes in Europe at the beginning of the sixteenth century. He had an active and inquiring mind, and sought to extend his knowledge by observation and experiment. His interests included medicine and surgery, physiology, alchemy, and even psychology. Thus, in 1493, he tried to determine by a direct experiment the nature of that "primitive tongue" which Ben Jonson, at a later day and in jocular mood, supposed to be High Dutch. "The king gart [caused] tak ane dum woman and pat hir in Inchekeytht [island]", wrote Lindesay of Pitscottie, "and gaif hir tua young bairnes, and gart furnische them of meit, drink, fyre and candell, claithis [clothes], witht all uther kynd of necessaris, desyrand to knaw quhat langage thir bairnes wald speik quhene they came to lauchfull aige. Sum sayis they spak goode hebrew bot as to my self I knaw not."

James's excursions into alchemy were probably determined by his interest in medicine, because of the potent medicinal and rejuvenating virtues which were ascribed to the Philosopher's Stone. His chief associate in a prolonged series of alchemical experiments was a certain John Damian, an ingenious and personable Italian or Frenchman. Under Damian's inspiration and direction, James established Scotland's first research laboratory in Stirling Castle.

James provided his alchemist with an emolument and the necessary leisure for research by creating him Abbot of Tungland, in Galloway. The new ecclesiastical dignitary preferred the smells of his laboratory to the odour of sanctity, and feared the effect of the laboratory smoke upon his costly religious vestments.

The accounts of the Lord High Treasurer of Scotland from 1501 to 1513 throw some interesting light upon the nature and cost of the materials which Damian and his associates used in their attempts to prepare the *quinta essencia* (Philosopher's Stone, or Elixir of Life). Among them were gold, silver, quicksilver, aqua vitæ, saltpetre, sal ammoniac, litharge, salt and sugar. The prices of apparatus, the wages of the laboratory attendants, and even the cost of the alchemist's attire, are detailed in the Treasurer's records.

Three kinds of aqua vitæ, or whisky, are indicated by the adjectives "small", "ordinary" and "thrice-drawn". Although in the strange Scotland of James IV whisky must have been a rare drug reserved mainly for medicinal purposes, the Abbot of Tungland and his collaborators in the Great Work were able to secure and find uses for surprisingly large amounts.

Among occasional visitors to the Stirling laboratory was one Broun, a master "potingair of Sanctandrois". Skilled in the distillation of "waters" perfumed with essential oils, and also in the primitive sugar "potingry" of those times, this worthy apothecary was the unconscious prototype of the St. Andrews chemists of a later age.

The Abbot's attempts to achieve the Stone were interrupted in 1507, as a result of another of his spectacular activities. In the quaint language of Bishop Lesley: "This Abbott tuik in hand to flie with wingis; and to that effect he causet mak ane pair of wingis of fedderis". Equipped with these movable feathered wings, he took off from the lofty battlements of Stirling Castle for a flight to Paris; "bot shortlie he fell to the ground and brak his thee bane". Nothing daunted, the courageous experimenter ascribed his downfall "to that thair was sum hen fedderis in the wingis", which yearned and coveted the midden and not the skies: if the wings had been made entirely of eagles' feathers, they would have exerted a natural tendency to soar into the heavens!

The alchemical experiments in Stirling Castle were continued until 1513, when the interest of the Scottish crown in alchemy came to an untimely end with the death of James IV upon the tragic field of Flodden. A century and a half later this interest in science found a rebirth in two of James's distant descendants—Prince Rupert of Bavaria and King Charles II.

* Abstract of a lecture delivered to the Society for the Study of Alchemy and Early Chemistry on May 11, at the British Academy, Burlington Gardens, London, W.1, by Prof. John Read, F.R.S.

Aeronautical Research in Australia

THE growth of civil aviation and the necessity for increased attention to Air Force requirements led the Australian Government last year, at the instance of the Council for Scientific and Industrial Research, to invite Mr. H. E. Wimperis, retiring director of research to the Air Ministry, to visit the Commonwealth to examine the existing situation with a view to the inauguration of aeronautical research. His report was presented in December last and its recommendations have been generally approved by Cabinet.

It was desired that such facilities as might be provided for aero-engine work should be extended to cover automobile engines: hence the first recommendation provides for an engineering research establishment at a suitable centre (almost certainly Melbourne), equipped for experimental work in wind tunnels, for engine tests for both aircraft and automobile use, and for physical tests of aircraft instruments and other apparatus. The laboratory will be administered by the Council for Scientific and Industrial Research, the programme of research, under a civilian superintendent, being supervised by an Australian Aeronautical Research Committee with an independent chairman. Its membership will include official representatives of the military and civil aviation departments, of meteorological services and radio communications, together with non-official members having special scientific and technical qualifications.

So far as practicable, use will be made of existing facilities at universities and in defence laboratories,

the former being encouraged to undertake approved investigations in aeronautics for which they are fitted. It is proposed to create a chair and department of aeronautics (probably in the University of Sydney) to ensure a supply of trained personnel for military and civil aviation and for aeronautical construction. A readership in meteorology will also be established.

The Research Committee will form sub-committees to deal with aerodynamics; power plant; navigation and meteorology; materials; accidents; and air inventions. It will also be required to investigate the use of Australian-produced materials and processes in aircraft construction; and it will maintain a general information service.

On the automobile side it is proposed to set up an Industrial Research Committee to assist the Council with advice on a programme of research and to seek the co-operation of the industry in making provision for the carrying out of it.

It will be some considerable time before the projected laboratory is completed, but a start will be made in the current financial year. Provision is being sought for £143,000 to cover capital expenditure, and the estimated annual maintenance cost is put at £12,000.

Electrical Interference with Radio Reception

IT has been well known for some years that a large proportion of electrical apparatus and plant, of both a commercial and domestic character, produces discontinuous electrical currents, which can result in interference with radio reception over a wide range of frequencies. In view of the widespread use of broadcast receivers in everyday life, it is very much in the public interest that all possible steps should be taken to mitigate the results of such interference. In NATURE of August 1, 1936, reference was made to the work of a joint committee representative of all sections of the electrical and radio industries in the study of this problem. Following the report of this committee, a number of other committees have been at work under the auspices of the British Standards Institution compiling specifications of components which may be fitted to electrical apparatus and to radio receivers with the object of reducing the nuisance of interference to a minimum. Concurrently with the operation of these committees, the Post Office on one hand and the British Electrical and Allied Industries Research Association on the other, have been carrying out investigations on a comprehensive scale.

The results of such investigations were summarized at a meeting of the Wireless Section of the Institution of Electrical Engineers on April 6, when a paper was read by Mr. A. J. Gill (of the Post Office) and Dr. S. Whitehead (of the Electrical Research Association) under the title "Electrical Interference with Radio Reception". The paper described the method of assessment of the interference to radio reception by electrical equipment, and the degree to which such interference must be reduced to permit satisfactory service. Various methods of measuring the interference have been developed in different countries and the most reliable of these have been compared with the view of securing uniformity of interpretation of the results.

With the aid of such apparatus, a study has been made of the interference produced under typically practical conditions from such electrical sources as trolley-buses, high-voltage overhead power lines, high-frequency medical apparatus and surgical equipment, electric lifts, telegraph and telephone plant, domestic appliances and the ignition systems of motor-cars. It has been found that while in some cases the interference is experienced by direct radiation from the source, it is more common for the interfering voltages to set up currents in the electrical supply network, from which the mains at the receiving station radiate locally to the receiving aerial. Following this appreciation of the nature and magnitude of the source of the interference, a detailed study has been made of methods of suppression to the level required to give satisfactory reception. Where possible, it is naturally best to suppress the interference at its source; but where this is either impracticable or unduly expensive, it is necessary to take steps to improve conditions at the receiver itself. Very effective methods of suppression have been worked out in some detail and some typical results of applying these are described in the paper. It is by the continued friendly co-operation between the electrical and radio industries that continued progress is to be anticipated as the methods of suppression and mitigation now available come into widespread use.

One of the methods adopted by the Post Office in dealing with this matter has been by co-operation with the ordinary broadcast listener in investigating complaints of interference brought to the notice of this Department. The number of such complaints brought to the attention of the Post Office has increased from some 10,000 in 1931 to nearly 50,000 in 1937. To deal with this problem, a full-time staff of about 250 are employed, and these have been trained by special courses of instruction. The equipment available to this staff comprises 110 motor-vans, each supplied with an interference locator, portable wireless receiving set, screened leads and a number of suppression components for demonstration purposes. The work of this staff has already produced a great amelioration in the conditions of broadcast reception. It is interesting to note that in some cases the broadcast listener is himself the cause of much of the interference of which he complains; for although it may not be usual in any one household to listen to broadcast programmes at the same time as the vacuum cleaner or electrically driven sewing machine is in use, these items may cause considerable interference to neighbouring listeners. Perhaps the time is not far distant when the man in the street may insist that all new domestic electrical appliances which he purchases will have been certified as 'interference free'.

The paper, to which reference was made above, concludes with an extensive bibliography, which indicates the large amount of scientific and technical work which has been devoted to this subject.

Science News a Century Ago

Magnetism at Low Temperatures

ON May 17, 1838, Faraday wrote in his Diary: "Graham has lent me Thilorier's Carb. acid apparatus and I have been experimenting with it in cooling metals and ascertaining their relation to Magnetism. The metals were in pieces, kept a while in the mixture of Ether and C.A. with solid C.A. in it, and moved either by platina wires or by wooden tongs. The temperature according to Thilorier would be about 112° below 0° of Fahrenheit." With these arrangements, Faraday proceeded to test the magnetic properties of a large number of metals at the low temperature obtained, but without exception "these gave no deflection by a double astatic needle that was exceedingly sensible to the smallest particle of iron or nickel". The experiments were in continuance of some he had made in December 1835, and were the outcome of an idea he had at the time that all metals might acquire magnetic properties at low temperatures similar to those of iron. In 1835, the lowest temperature he had been able to reach was about − 70° Fahrenheit.

Thilorier had recently developed in France his apparatus for liquefying and afterwards solidifying carbon dioxide; and he had published his important observation of the value of a mixture of solid carbon dioxide and ether as a refrigerant. Faraday, interested in the attainment of low temperatures, was quick to see the advantages of the new method. He used the mixtures of carbon dioxide and ether afterwards in experiments on the liquefaction of gases; but it is interesting to notice that his first thought, on hearing that a temperature lower than any he had previously used could be obtained, was to test his theories of magnetism by it.

The "Graham" from whom the apparatus was borrowed was almost certainly Thomas Graham, the chemist.

Magnetic Observations at Greenwich

ON May 21, 1838, at the Royal Observatory, Greenwich, as Airy records, "a magnet was suspended for the first time, Mr. Baily and Lieut. [afterwards Sir William] Denison being present". Airy had submitted a proposal for a magnetic observatory to the Admiralty two years before, and during the course of 1837–38 the observatory, a wooden building, had been erected in the form of a four-armed cross with equal arms, one axis being in the magnetic meridian. In 1840, the Magnetical and Meteorological Department was formed with James Glaisher, F.R.S. (1809–1903) as head. Glaisher held this position for thirty-four years. He was one of the first to adopt the photographic self-recording instruments of Charles Brookes (1804–79), and in 1850 he founded the Royal Meteorological Society, of which he was the secretary from 1850 until 1872. He was also well known for his balloon ascents for scientific purposes made during 1862–69 on behalf of the British Association Committee. On one of these, made on September 5, 1862, with Coxwell, he reached a height of seven miles.

Launch of the S.S. *British Queen*

AT Limehouse, on May 24, 1838, Curling and Young, the shipbuilders, launched the Atlantic steamship *British Queen*, then the largest vessel of her kind in the world. She was constructed for the British and North American Steam Navigation Company, of which the American lawyer, Junius Smith (1780–1853), was the founder, and the famous African explorer, Macgregor Laird (1808–61), was the secretary. She was 275 ft. long from figurehead to taffrail, and 64 ft. wide over the paddle boxes. After her launch, she was sailed to the Clyde, where her engines of 500 horse-power were fitted by Robert Napier. She was one of the first vessels fitted with surface condensers instead of jet condensers, and was able to use fresh water in her boilers. Her first trans-Atlantic voyage was made in July 1839, when she crossed from Portsmouth to New York in 15½ days. She returned to England in August, and during 1839 made two more double passages. She made five double crossings in 1840 and one in 1841, after which she was sold to the Belgian Government. She was somewhat larger than her famous rival the *Great Western*, which, however, proved a slightly faster vessel.

Supply of Rubber from India

ON May 26, 1838, at a meeting of the Asiatic Society, Dr. Royle, the secretary, read a paper entitled "On Caoutchouc or Indian Rubber". He stated that caoutchouc was known to the Peruvians, and to the Chinese in early times. Condamine first noticed it, in his voyage down the River Amazon in 1743, by the name *cachuchu*. Dr. Priestley afterwards mentioned it as a rubber-out of pencil marks. Dr. Royle said that, a few years before, about five tons were imported; now 500 tons are annually brought into London and Liverpool alone, and the quantity is daily increasing.

Caoutchouc is produced by numerous trees and shrubs of the natural families of the Euphorbiaceæ Apocynaceæ, Asclepiadaceæ and Moraceæ in tropical parts of the globe, where high temperature is combined with moisture. It is imported from Para and other places in South America, Vera Cruz, Sierra Leone, Java, Penang and Singapore. It is also produced in India, being obtained from *Ficus elastica*, a native of the forests of Silhet and Lower Assam. It was of excellent quality, and feeling assured that the tree must be abundant and knowing that it could be easily grown in every part of India he (Dr. Royle) addressed letters on the subject to the societies and individuals in Calcutta. The replies proved that the supply of caoutchouc was inexhaustible.

A French Scientific Expedition

IN its column of Miscellanea for May 26, 1838, the *Athenæum* said: "We have frequently had to report the progress of the Bonite during her voyage round the world in order to take out the consular agents of France to different colonies. The following is a brief summary of the scientific labours of the officers on board. The voyage was completed in 631 days during which the corvette only anchored 151 days; it has therefore been a matter of surprise that so much should have been done for zoology, for among a considerable collection of rarities five have been added, which form types of new genera, and of which there was either no vestige in museums or only imperfect specimens; and beside these there are many new species. . . . The phosphorescence of the sea has been an object of continual research and the

organised beings which cause it have been carefully preserved in spirits of wine. . . . With respect to Physics, observations with barometer, thermometer and other instruments have been made at every hour of the day and night. Some experiments made with the apparatus of M. Biot to ascertain the composition of sea water at a great depth have produced some unexpected results; and among other things Terrestrial Magnetism has been carefully studied. M. Gaudichaua has been equally indefatigable with respect to Botany, and has brought home an immense collection of woods, plants, fruits, seeds, drawings and notes. . . ."

University Events

ABERDEEN.—The A. W. Garden fellowships will be awarded in June by the Senate of Aberdeen University. They are tenable from 3–5 years, and are of an annual value not less than £200. Graduates of medicine of any British university are eligible, but preference will be given to Aberdeen graduates. Application should be made to the secretary of the University, Marischal College, Aberdeen, before May 31.

CAMBRIDGE.—B. Cooper, of Clare College, has been appointed University demonstrator in engineering.

An election to the Isaac Newton studentships will be held early in the Michaelmas Term 1938. These studentships are for the furtherance of advanced study and research in astronomy (especially gravitational astronomy, but also including the other branches of astronomy and astronomical physics) and physical optics. Those members of the University are eligible for the studentship who have obtained a degree in the University, and who were under the age of twenty-five years on the first day of January 1938.

At St. John's College, the following have been elected to fellowships: Dr. D. H. Valentine, University demonstrator in botany; G. C. Evans.

OXFORD.—M. A. Jennings, Lady Margaret Hall, has been elected to the Schorstein research fellowship in medicine.

A. C. Hardy, of Exeter College, professor of zoology and oceanography in University College, Hull, has been granted the degree of D.Sc. for his work on plankton.

PERTH, W.A.—On March 31 the University of Western Australia, Perth, reached the semi-jubilee of its teaching work, and the occasion was celebrated by a conversazione in the Winthrop Hall of the University held on April 29.

Prof. H. E. Whitfeld, vice-chancellor of the University, has been granted extended leave to visit Europe, America and South Africa. During his absence, Prof. A. D. Ross, of the chair of physics, will be acting vice-chancellor.

SHEFFIELD.—Dr. R. P. Linstead, lecturer in chemistry in the Imperial College, has been appointed to the chair of chemistry, in succession to Prof. G. M. Bennett, who has resigned.

Societies and Academies

London

Royal Society (*Proc.*, A, **165**, 453–595, April 27, 1938).

W. R. G. ATKINS: Photo-electric measurements of the seasonal variations in daylight around 0·41μ, from 1930 to 1937.

J. S. FOSTER, G. O. LANGSTROTH and D. R. MCRAE: Quantitative spectrographic analysis of biological material. (3). A method for the determination of sodium and potassium in glandular secretions.

C. T. ARCHER: Thermal conduction in hydrogen-deuterium mixtures.

D. S. KOTHARI: The theory of pressure-ionization and its applications.

A. FAGE: The influence of wall oscillations, wall rotation, and entry eddies, on the breakdown of laminar flow in an annular pipe.

N. FEATHER and E. BRETSCHER: Uranium Z and the problem of nuclear isomerism.

D. H. BANGHAM and S. MOSALLAM: The adsorption of vapours at plane surfaces of mica. (1).

C. F. ELAM: The influence of rate of deformation on the tensile test with special reference to the yield point in iron and steel.

Proc., A., **166**, 1–177, May 4, 1938.

M. BLACKMAN: On the diamagnetic susceptibility of bismuth.

F. W. JONES: The measurement of particle size by the X-ray method.

A. D. MISENER: The resistance of superconducting cylinders in a transverse magnetic field.

B. F. J. SCHONLAND, D. B. HODGES and H. COLLENS: Progressive lightning. (5). A comparison of photographic and electrical studies of the discharge process.

H. J. WOODS: X-ray studies of the structure of hair, wool, and related fibres. (4). The molecular structure and elastic properties of the biological cells.

T. E. ALLIBONE and J. M. MEEK: The development of the spark discharge.

N. KEMMER: Quantum theory of Einstein-Bose particles and nuclear interaction.

H. FRÖHLICH, W. HEITLER and N. KEMMER: On the nuclear forces and the magnetic moments of the neutron and the proton.

Paris

Academy of Sciences, March 21 (*C.R.*, **206**, 865–960).

MARCEL DELÉPINE: A special action of catalytic nickel during the hydrogenation of 2-methyl-4-amino-5-cyanopyrimidine.

JEAN CABANNES, JEAN DUFAY and JUNIOR GAUZIT: Presence of sodium in the upper atmosphere. From observations on the yellow radiation of the nocturnal sky, made by interference methods, it is concluded that the vapour of sodium is a permanent constituent of the atmosphere.

LUCIEN DANIEL: An unquestionable case of the heredity of acquired characters. Results of experiments on the grafting of the artichoke on the annual sunflower, tubercles appearing on the roots of the latter. In the fifth generation raised from seed, the variety *Helianthus tuberosus Costantini* has been found and this has inherited various characters of the grafted ancestor, including the tubercular roots. This variety, cultivated through the tubers, preserves the production of tubers on its roots.

MARC KRASNER: The number of primitive superbodies of a given degree and the number of metagaloisian superbodies of a given degree of a body of g-adic numbers.

LÉONIDAS KANTOROVITCH: The continuity and prolongation of linear operations.

ASSÈNE DATZEFF: The graphical integration of certain differential equations.

V. A. KOSTITZIN: The Mendelian coefficients of heredity.

MME. CHRISTIANE PAUC: The geometrical interpretation in non-holonome varieties of the theories of integration of systems of Pfaff equations.

FRÉDÉRIC ROGER: The equivalence of the ideas of quadrature and of primitive.

JEAN VILLEY: Carburation by transference.

ROGER KLING and NUMA MANSON: Liquid jets impelled with supersonic velocities.

ROBERT FLEURENT and MAURICE BEAUVILAIN: The measurement of the time of reflection and acoustic levels by means of the fluxmeter.

PIERRE BIQUARD: Study of the propagation of ultra-sounds in liquids under pressure. Description of experiments on benzene, toluene, methyl acetate and carbon tetrachloride at pressures ranging up to 700 kgm. per sq. cm.

SERGE GORODETZKY: Analysis of the working of a selector with multiple coincidences. Description of an experimental arrangement.

MLLE. MARGUERITE QUINTIN: The potential of cadmium in cadmium benzenesulphonate.

GEORGES AHIER: Some dispersive liquids. Suggestions for various liquids capable of replacing ethyl cinnamate in prisms, possessing a lower temperature coefficient for the index of refraction and being less liable to change.

RAYMOND RICARD: The first spark spectrum of cæsium.

MME. IRENE CURIE and PAUL SAVITCH: The radio-element with a period of 3·5 hours formed in uranium irradiated with neutrons.

MLLE. MARCELLE PERNOT: The system mercuric iodide, cæsium iodide and water.

CLÉMENT COURTY: The calcination residues attracted by a magnet. The application of the Curie-Chéneveau magnetic balance to the determination of minimal quantities of iron.

VICTOR AUGER: The molybdic acid, H_4MoO_5. This acid is the yellow deposit from nitromolybdic solutions, and always contains ammonia. Various alternative methods of preparation are compared.

ANDRÉ BOULLÉ: The dehydration of acid sodium pyrophosphate.

MME. YVONNE KHOUVINE and GEORGES ARRAGON: The acetylation of perseulose.

MARTIN BATTEGAY and ROBERT KREBS: The thiocarbamic esters.

MAX MOUSSERON and ROBERT GRANGER: The dealkylation by sulphuric acid of the monoethers of the 1,2-cyclanediols with C_5 and C_6.

P. BELLAIR: The tectonic arrangement of the Provençal accidents.

EM. DE MARTONNE: The tropical model in Brazil.

RENÉ BERNARD: The interferential study of the yellow radiation λ 5893 A. of the twilight sky and the proof of the presence of sodium in the upper atmosphere (see also NATURE of April 30, p. 788).

GEORGES DÉJARDIN: The possible presence of certain lines of the neutral atom of sodium in the spectrum of the night sky. The hypothesis of the cosmic origin of atmospheric sodium cannot be rejected *a priori*.

GEORGES LEMÉE: The ecological characters of the Europeo-Atlantic floral element in the north-west of France.

CONSTANTIN DAWYDOFF: The endolarval metamorphosis in some Phyllodocians of Indo-China.

JEAN HENRI VIVIEN: The existence of accessory glands in the genital tract in the male of *Gobius paganellus*.

LÉON ACOLAT: The distribution of the arterial and venous blood in the central arteries of batrachians and reptiles.

HENRI BIERRY and BERNARD GOUZON: The spectral detection of the œstrogenic hormones in the urine of a pregnant woman. The method described, based on fluorescence spectra, characterizes the œstrogenic hormones, without confusion with cholesterol or other interfering substances.

MME. VERA DANTCHAKOFF: The role of hormones in the manifestation of the sexual instincts.

MAURICE LEMOIGNE, PIERRE MONGUILLON and ROBERT DÉSVEAUX: The reduction of nitrous acid by cystein and glutathione. Cystein and glutathione, like ascorbic acid, reduce nitrous acid with formation of hydroxylamine and ammonia.

EMILE ROUSSEAU: Melanine fixed on the non-dialysable protein complexes of the blood and of the urine of cancerous patients.

A. SARTORY, J. MEYER and J. WAELDELÉ: Contribution to the study of a violaceine obtained in the crystalline state and arising from a violet bacillus isolated from the pus of a dental abscess.

CONSTANTIN LEVADITI, JULES BRIDRÉ and MME. DENISE KRASSNOFF: The approximate dimensions of the claveau virus determined by ultrafiltration.

MARCEL LISBONNE, GEORGES ROMAN and GÉRARD RENOUX: The vaccination of the guinea pig against the brucellic infection (*Brucella melitensis*).

MAX ARON: Serological researches on the existence of specific properties of the urine and blood of tuberculous patients.

IVAN BERTRAND and RAOUL LECOQ: Anatomical alterations of the peripheral nerves in the course of acute disturbance of food equilibrium of glucidic origin.

Dublin

Royal Irish Academy, April 11.

J. C. HARPER and J. J. HARTLEY: The Silurian Inlier of Lisbellaw, Co. Fermanagh, with a note on the age of the Fintona Beds. This inlier, bounded by faults, was, in the Survey map of 1881, shown as consisting of both Llandeilo and upper Llandovery deposits. The whole is now shown to belong to the *Monograptus gregarius* zone of the Middle Valentian. It is one of the most north-westerly exposures of the Silurian System in the British Isles. A coarse conglomerate occurs having a sharp junction with the prevailing mudstones. *Pterospis* is reported from the adjacent Fintona Beds, thus fixing their age as Lower O.R.S.

Cape Town

Royal Society of South Africa, March 16

POTTERY FROM THE SALISBURY DISTRICT, SOUTHERN RHODESIA. (1) Rev. Fr. Stapleton: The topography of Echo Farm, Didcot Farm, and the ruins on Didcot

Farm. (2) J. F. Schofield: The pottery from Echo Farm, Didcot Farm, and the ruins on Didcot Farm. (3) J. F. Schofield: A proposed classification for the pottery of Southern Rhodesia. (4) J. F. Schofield: Notes on iron implements from Echo Farm.

Geneva

Society of Physics and Natural History, March 3.

RENÉE DOVAZ: The action of pre-pituitary extracts on the development of the organ of Bidder in the male castrated toad. Injections of prolan from the urine of ovariectomized woman, insertions and injections of hypophyses of frogs and toads into male castrated toads stimulate the transformation of Bidder's organ into the ovary, without, however, resulting in development as rapid as that described by Houssay, whose views were based on the weight of the organ. The effect on the ovocytes is in direct relation with the period of latency after castration. In the most favourable cases, a commencement of vitellogenesis is noticed in the ovocytes. The transformation observed is of the same order of magnitude as that undergone by the ovaries themselves, as will be described in a later note.

RENÉE DOVAZ: The stimulation of sexual maturity in immature male and female toads, under the influence of pre-pituitary extracts. The injection into toads (*Bufo vulgaris*) of pituitary extracts (ox, toad, frog) and of prolan from the urine of ovariectomized woman, slightly stimulates the ovogenesis of immature females, and, more actively, the ovogenesis of the Bidder's organs of castrated males, still more actively, the spermatogenesis of immature males or, in a state of sexual prematurity, Bidder's organ behaves abnormally, and is activated at the same time as the ovary and testicle. The study of the problem would require that attention should be given to the time factor, on account of the slow development of the batrachians.

LUDWIG BLUM: The polarity of the buffer action in the tissues of an aquatic plant (*Potamogeton densus*). The buffer power of an aquatic plant (*P. densus*) has been measured towards acids and bases. The measurements were carried out on the apical and on the distal part of the stems. The *p*H of the stems is always distinctly acid and the buffering power against acids is more important than against bases. In general, the apical part shows a higher buffering power than the distal part.

WILLY J. SCHROEDER: The discovery of submarine coulées of lava in the Flysch of the sheet of la Brèche. The author has identified in the crest situated between "Sur le Verchaix" and the pass of Jouxplane to the north of Samoëns (Haute-Savoie) submarine coulées of lava interstratified in the lower levels of the Flysch of the la Brèche sheet. Certain parts of the coulée are massive, others have a typical pillow-lava structure.

WILLY J. SCHROEDER: Remarks concerning the coulées of lava in the Flysch in the la Brèche sheet. The most probable hypothesis concerning the origin of these coulées would be the following: A good part of the basic eruptive rocks of the Flysch of the la Brèche sheet would be remnants of submarine coulées of lava which date from the period of the deposit of the Flysch. The la Brèche sheet would then come from the eastern part of the zone of the Flysch and the crystalline rocks forming the lava would come from the zone of the green rocks of Versoyen.

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Monday, May 23

WELLCOME INSTITUTE FOR MEDICAL RESEARCH, at 5.30.—Dr. J. W. Trevan: "Variation in the Response of Animals to Drugs" (succeeding lectures on May 24 and 25).*

UNIVERSITY OF OXFORD.—Prof. J. H. Hutton: "A Primitive Philosophy of Life" (Frazer Lecture).

Tuesday, May 24

ROYAL COLLEGE OF PHYSICIANS, at 5.—Prof. F. R. Fraser: "The Clinical Aspects of the Transmission of the Effects of Nervous Impulses by Acetyl Choline". (Croonian Lectures. Succeeding lectures on May 26 and 31).

EUGENICS SOCIETY (at the Royal Society, Burlington House, W.1), at 5.15.—D. V. Glass: "Population Policies in Scandinavia and Elsewhere".*

BIRKBECK COLLEGE, LONDON, at 6.—Prof. J. B. S. Haldane, F.R.S.: "The Marxist Philosophy" (Haldane Memorial Lecture).*

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Prof. H. J. Collins: "Engineering Problems of Modern Building Construction" (Chadwick Public Lecture).*

Wednesday, May 25

NATIONAL INSTITUTE OF INDUSTRIAL PSYCHOLOGY (at the London School of Hygiene and Tropical Medicine), at 5.30.—Dr. Dwight L. Palmer: "Industrial Relations in the United States and Great Britain" (succeeding lectures on May 30, by Dr. C. H. Northcott, and on June 1, by Prof. John Hilton).*

Thursday, May 26

ROYAL SOCIETY, at 2.30.—Discussion on "Cosmic Rays" to be opened by Prof. P. M. S. Blackett, F.R.S.

Friday, May 27

GEOPHYSICAL DISCUSSION (at the Royal Astronomical Society), at 4.30.—"The Topography of the Ocean Floors" (Opener: Lieut.-Colonel R. B. S. Sewell, F.R.S.).

ROYAL INSTITUTION, at 9.—Prof. J. Chadwick, F.R.S.: "The Cyclotron and its Applications".

RUBBER TECHNOLOGY CONFERENCE, May 23–25. To be held at the Hotel Victoria, Northumberland Avenue, London, W.C.2.

S. T. Rowe: President.

LINNEAN SOCIETY OF LONDON, May 24–26. One hundred and fiftieth anniversary to be held in London.

May 24, at 3.—Dr. J. Ramsbottom: "Linnæus and the Species Concept".

May 25, at 10.—Symposium on "The Concept of Species from the Time of Linnæus to the Present Day".

May 26, at 10.—Symposium on "Geographical Isolation as a Factor in Species Formation".

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

LECTURERS IN MATHEMATICS, PHYSICS, CHEMISTRY AND CIVIL AND MECHANICAL ENGINEERING in the Woolwich Polytechnic, London, S.E.18—The Secretary (May 21).

LECTURER IN TELECOMMUNICATIONS (June 3) and LECTURER IN MECHANICAL ENGINEERING (May 23) in the Polytechnic, Regent Street, London, W.1—The Principal.

HEAD OF THE DEPARTMENT OF ECONOMICS AND SOCIAL STUDIES in the City of Birmingham Commercial College, Suffolk Street, Birmingham, 1—The Principal (May 25).

DEMONSTRATOR IN ELECTRICAL ENGINEERING in the Military College of Science, Woolwich, S.E.18—The Commandant (May 26).

LECTURER IN MECHANICAL ENGINEERING in King's College, London—The Secretary (May 27).

CHEMISTS under the War Department Chemist—The Under-Secretary of State (C.5), The War Office, S.W.1 (May 28).

TEACHERS OF CHEMISTRY AND OF MECHANICAL ENGINEERING in the Luton Technical College—The Director of Education, Shire Hall, Bedford (May 28).

HEAD OF THE DEPARTMENT OF PHYSICS in the Chelsea Polytechnic, London, S.W.3—The Principal (May 28).

LECTURERS IN MATHEMATICS, CHEMISTRY AND ENGINEERING in the Derby Technical School—The Clerk to the Governors, Derby Technical School, Normanton Road, Derby (May 28).

LECTURER IN MECHANICAL ENGINEERING in the St. Helen's Municipal Technical School—The Director of Education, Education Office, St. Helens (May 28).

TEACHER OF ENGINEERING DRAWING, MATHEMATICS AND SCIENCE in the Rochdale Municipal Technical School—The Secretary (May 30).

ASSISTANT (Grade III) for abstracting scientific and industrial papers at the D.S.I.R., 16 Old Queen Street, Westminster, S.W.1—The Establishment Office, (May 30).

TEXTILE ENGINEER to the Wool Industries Research Association, Torridon, Leeds—The Secretary (May 31).

UNIVERSITY DEMONSTRATOR IN CHEMISTRY in the University of Cambridge—Prof. H. G. W. Norrish, University Chemical Laboratory, Pembroke Street, Cambridge (May 31).

TEACHER OF PHYSICS in the Rugby College of Technology and Arts—P. I. Kitchen, 61 Clifton Road, Rugby (May 31).

BACTERIOLOGIST in the Veterinary Department, Kenya—The Director of Recruitment (Colonial Service), 8 Buckingham Gate, London, S.W.1 (May 31).

LECTURER IN ELECTRICAL ENGINEERING in the Carlisle Technical School—The Director of Education, Education Offices, Fisher Street, Carlisle (June 1).

ASSISTANT LECTURER IN CHEMISTRY in the University of Manchester—The Registrar (June 2).

LECTURER IN MATHEMATICS in University College, Dundee—The Secretary, University, St. Andrews (June 4).

TWO UNIVERSITY LECTURERS IN ZOOLOGY and ONE UNIVERSITY DEMONSTRATOR IN BOTANY in the University of Cambridge—Dr. A. D. Imms, Department of Zoology, Downing Street, Cambridge (June 7).

TWO CHEMISTS AND TWO FIELD GEOLOGISTS in the Geological Survey Department of the Federated Malay States—Director of Recruitment (Colonial Service), 8 Buckingham Gate, Westminster, London, S.W.1 (June 10).

PROFESSOR OF BIOCHEMISTRY in the All-India Institute of Hygiene and Public Health, Calcutta—High Commissioner for India, General Department, India House, Aldwych, W.C.2 (June 24).

LECTURER IN CHEMISTRY in the University of Reading—The Registrar.

JUNIOR INVESTIGATOR to the British Non-Ferrous Metals Research Association—The Secretary, B.N.F.M.R.A., 1–6 Regnart Buildings, Euston Street, N.W.1.

Reports and other Publications

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Non-Ferrous Metals Research Association Research Reports. Association Series, No. 473: Elastic Properties of Non-Ferrous Metals and Alloys; Collected Data. By Dr. J. McKeown and E. D. Ward. Pp. 35. (London: British Non-Ferrous Metals Research Association.) 6*s*. [254

King's College: Dove Marine Laboratory, Cullercoats, Northumberland. Report for the Year ending July 31, 1937. (Third Series, No. 5.) Pp. 42+2 plates. (Newcastle-upon-Tyne: Marine Laboratory Committee of King's College.) [264

Institution of Professional Civil Servants. Annual Report of Council for the Year 1937. Pp. xiv+66. (London: Institution of Professional Civil Servants.) [264

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